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DEVOTED TO TEXTILE WET-PROCESSING

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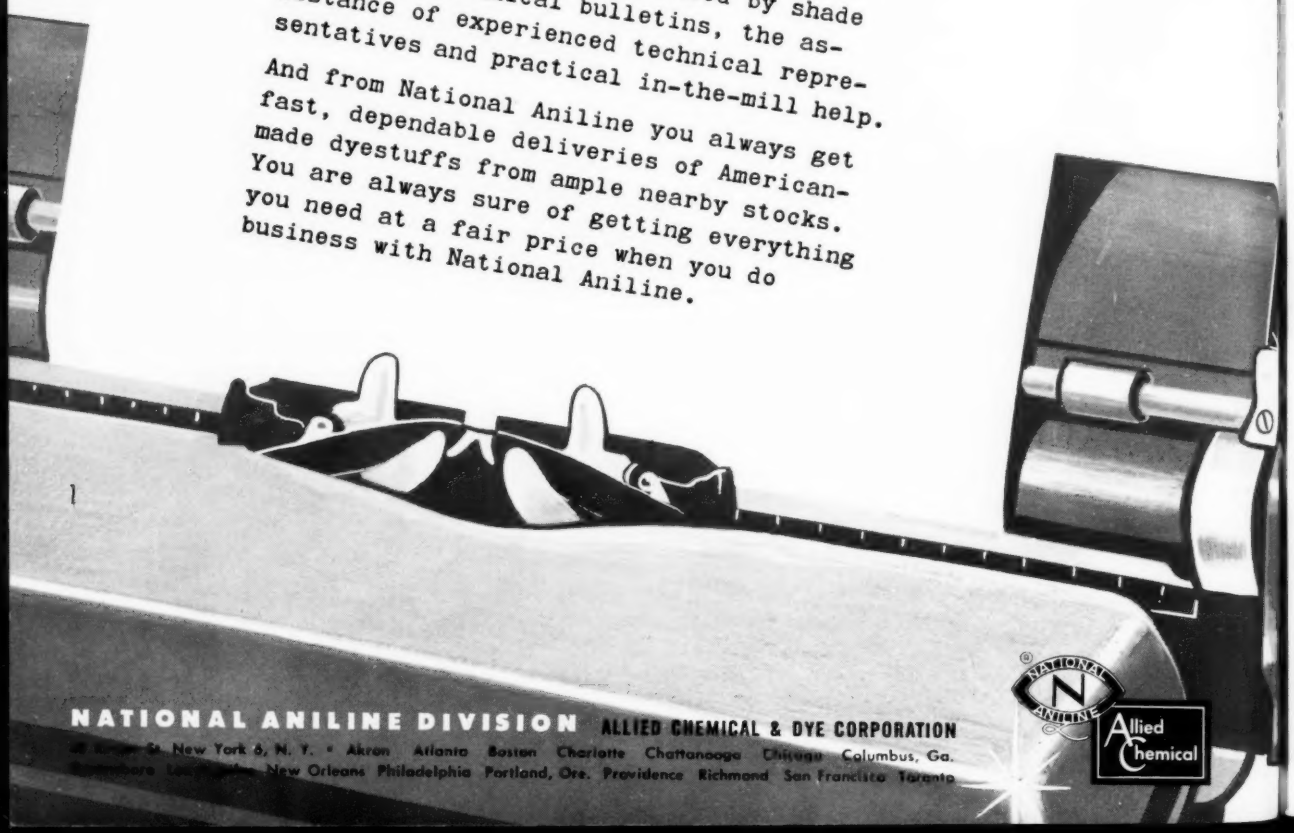

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NATIONAL ANILINE Allied Chemical

AMERICAN
DYESTUFF REPORTER

Volume 46 May 6, 1957 Number 9

A RAPID TEST FOR RESIN IDENTIFICATION ON TEXTILES

JOHN H HOWARD

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Cranston, R I

Aminoplasts may be removed from cotton fabrics by acid hydrolysis. Those of the urea-formaldehyde type react with 15% sodium hydroxide to liberate ammonia. Urea-formaldehyde, ethylene urea-formaldehyde, and melamine-formaldehyde resins all hove different rates of acid hydrolysis. Formaldehyde is liberated in the process and provides a means of further identifying the respective resins through reaction with phenylhydrazine and finally ferric chloride giving a characteristic color. These reactions are the bases of this test.

INTRODUCTION

A NUMBER of methods (*1, 2, 3, 4*) have been proposed for the identification of thermosetting resins used as textile finishing materials. All are quite tedious and involved.

Generally speaking, aminoplasts are the most used resins in textile finishing. To date the Van Loo, et al (*5*) spot test has been the best tool available for their identification. This test is based upon the fact that acid hydrolysis will strip the aminoplasts from the fabric, liberating formaldehyde which can be reacted with phenylhydrazine and finally with ferric ions to form a colored complex (*6, 7, 8*). The various thermosetting resins differ in their rates of hydrolysis, thus affording a means for their identification since the rate of hydrolysis determines the amount of formaldehyde liberated and ultimately the color of the iron complex.

The Van Loo, et al test leaves much to be desired in that colored grounds are difficult, if not impossible, to analyze: epoxy resins report as melamines; the simple act of laying an untreated sample on a resin-treated sample causes the untreated sample to report a resin present, etc.

Swann and Esposito (*9*) report that only urea-formaldehyde resins liberate ammonia on hydrolysis with 14% potassium hydroxide. The following test is a modification of the Van Loo, et al test incorporating the observation of Swann and Esposito, and allows a positive means for identifying urea-formaldehyde, melamine-formaldehyde, and ethylene urea-formaldehyde resins, regardless of the color of the fabric.

PROCEDURE

Wash sample for 5 minutes in a beaker at 160° F using 0.1% soap chips solution, rinse, and dry the sample. Cut two pieces from each unknown, one ½″ x ½″ and the other ½″ x 3″. Place each in separate test tubes, add 7 ml of water, 2 drops 85% ortho phosphoric acid, heat to boiling over a Bunsen flame, and let stand one minute. To the test tube containing the larger sample of cloth add 3 ml of 50% aqueous sodium hydroxide, heat to a boil, let stand 10 minutes, heat to a boil again, and test the vapors with moistened red litmus paper for 10 seconds. A color change in the litmus indicates a urea-formaldehyde resin to be present. If the color change is not too pronounced, bring the sample to a boil again and retest the vapors using the same piece of moistened litmus paper.

From the test tube containing the smaller sample of fabric remove a drop of liquid after thorough mixing and place in a spot dish. Add 2 drops of 1% phenylhydrazine in 40% sulfuric acid, mix, let stand one minute, add 1 drop of 10% ferric chloride solution, mix, and note the color after five minutes. Run a blank using distilled water in place of the unknown.

RESULTS AND DISCUSSIONS

The sodium hydroxide test is a positive means for identifying the urea-formaldehyde resins. Care, however, must be taken that the litmus paper is not spattered by the contents of the test tube. Cationic softeners, ethylene urea-formaldehyde resins, melamine-formaldehyde resins, epoxy resins, and acrylonitrile latices do not report.

The phenylhydrazine-ferric chloride test separates the three types of resins as follows: ethylene urea-formaldehyde resins give a cherry-red color; urea-formaldehyde resins, a cherry red, reddish-brown, or dark brown color; melamine-formaldehyde resins, a pale brown color. These are differentiated further when the litmus test previously outlined is used. Acrylonitrile latices and epoxy resins give a very pale brownish-yellow color. Cationic softeners give a bright yellow. The blanks are a bright yellow.

TABLE I
Color Reactions of Various Resins

Resin or finishing material	*NaOH-red litmus*	*Phenylhydrazine-$FeCl_3$*
Ethylene urea-formaldehyde	no change	cherry red
Urea-formaldehyde	turns blue	cherry red through dark brown
Melamine-formaldehyde	no change	pale brown
Epoxy	no change	very pale brownish-yellow
Acrylonitrile latices	no change	very pale brownish-yellow
Cationic softeners	no change	bright yellow
Water	no change	bright yellow

SUMMARY

A rapid test for identifying aminoplasts on colored and uncolored cotton fabrics has been presented. The method entails acid hydrolysis of the resin followed by treatment with sodium hydroxide to absolutely identify urea-formaldehyde resins since only this type liberates ammonia on such treatment. The second part of the test involves acid hydrolysis of the resin followed by phenylhydrazine-ferric chloride treatment to form a color complex characteristic of the particular resin.

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A CHROMATOGRAPHIC METHOD FOR THE IDENTIFICATION OF AMINO ALDEHYDE FINISHES ON TEXTILES

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Descending paper chromatography is used in a simplified technique for the identification of the amino constituents hydrolyzed from amino-aldehyde finishes on textiles. Minute quantities are readily separated and detected, and a development time of three hours usually is adequate. The spots are made visible on the paper strips by treatment with formaldehyde, followed by curing and staining with Scarlet 4RA (*CI* 185).

INTERLABORATORY testing by ASTM- and AATCC-sponsored groups has shown the inadequacy of existing published methods (*6, 7, 8, 9*) for the qualitative analysis of amino-aldehyde finishes. Descending paper chromatography successfully overcomes some of the deficiencies of previous methods in that it detects most mixtures, warns of new and different finishes, indicates the presence of more than urea and melamine, and is independent of the type of fiber, dyeing, or cure. Extremely small samples are required for analysis, since the standard spot used here contains only about 0.00008 gram of amino substance.

In a routine technique, approximately 1 gram of fabric is taken, extracted with hot carbon tetrachloride and then with hot alcohol to remove finishes which may interfere with development. This is an important step, but not time consuming with small samples.

The fabric is then washed out with hot, distilled water, which takes out unset, slightly soluble, or readily hydrolyzable amino-aldehyde compounds if they are present. This water extract can be acid hydrolized and chromatographed, if desired, or directly chromatographed, using the method of Zahn for methylol compounds (*10*); since many methylol compounds are possible with each amino substance, the results may be difficult to interpret. Simpler systems result when the extracted textile sample is hydrolyzed at a gentle boil for 15 minutes with 20 times its weight of 0.1 N hydrochloric acid. Experiments at various concentrations of amino hydrolysate indicate sharpest and clearest spots with approximately 5 mg/ml, using a micropipette delivering about 0.015 ml. Thus, if the fabric contains 10% of acid hydrolysate, the hydrolysate can be used for spotting directly. With more or less resin, the liquor can readily be diluted or concentrated.

The spotting technique consists of drawing a thin line from edge to edge of ½" Whatman #1 filter paper strips, using inexpensive laboratory calibrated micropipettes. The developing solution that has given best results is made of normal butanol, ethanol, and water, 3:1:1, v/v/v. This is similar to the solvent used by Adachi (*1*) for urea. Several published methods are given by Block, Durrum & Zweig (*3*), including the use of phenol, butanol-acetic acid, butanol-ethanol, isobutyric acid, and lutidine, but they are unpleasanter to handle and smell.

The development is preferably carried out in a temperature-controlled area, such as an air-conditioned room at 70°F.

The equipment consists of a glass jar 24 inches deep, a plate glass cover with a small hole which is stoppered except when adding or removing solvent at the start and finish of development, and a stainless steel rack for holding small glass solvent troughs and antisiphon rods. The troughs are adjusted in height relative to the antisiphon rods so that the solvent rise is 1 cm. The filter paper strips are softly folded ½ and 2 inches from the end, the first position to be under the anchor bar, the second, the position of spotting, just past the contact with the antisiphon bar. The jar is held in readiness with a small dish of mixed solvent at the bottom. Prepared strips of about 20 inches in length are weighted with paper clips, which also assist handling, marked with the solutions to be chromatographed (with the help of a hot plate at about 150°F to assist drying of the spots), and set in position in the solvent troughs. The developing solution is added to the top level of each trough. In this way, rate of development is fairly constant. Standard equipment of this sort is available from many scientific supply houses, such as Harshaw Scientific, Cleveland, Ohio, whose setup H10979 was used in many of the tests.

With this equipment, 32 strips can be chromatographed simultaneously. The rate of solvent flow is approximately 4½ cm/hr. Knowns and unknowns can be run together, both on the same and separate strips. The strips are ready for marking of the solvent front by pencil and air drying, preferably in an air current under a hood, after 3 hours, but longer periods increase separations.

It should be noted that the resin hydrolysate and the original amino substance are not necessarily identical. In the case of dicyandiamide, the hydrolysate shows an Rf (distance from origin to substance ÷ distance from origin to solvent front) of 0.33, while dicyandiamide itself is at 0.54. The Rf values of a series of substances in common textile use is given in the following table:

	Hydrolysate from Methylol Compound	Test on Pure Amino Substance
Urea	0.41	0.41
Melamine	0.20	0.19
Thiourea	0.54	0.50
Dicyandiamide	0.33	0.54
Cyclic ethylene urea	0.15	not tested

The positions of the amino compounds can be revealed by spraying the developed and dried strips with a solution of 1:1 10% aqueous ammonium nitrate-30% formaldehyde; ironing with a "low rayon" setting, approximately 300°F for 10-20 seconds, to reform resin; and then staining with an aqueous slightly acidified solution containing a few drops of acetic acid and 0.2 g/l of Scarlet 4RA (*CI* 185). This is somewhat similar to the approach of Elod and Jorder (*4*), who stained the spot from the hydrolysate without first chromatographing. Other chemicals for making the amino substances visible, such as phenol-hypochlorite, phosphomolybdic acid and p-dimethylaminobenzaldehyde (*1, 3*), tend to show up the presence of too many adventitious substances. This is true also of ultraviolet light inspection, which causes fluorescence with cyclic ethylene urea and, to a slight extent, with thiourea; unfortunately,

inexplicable fluorescence and quenching may occur.

All methylated ureas and melamines so far tested have hydrolyzed to form the same amino products as ordinary urea and melamine. The presence of this alcoholated type of product can be determined by the method of Bitterli (2), which hydrolyzes, destroys the aldehyde, and detects the alcohol. If sufficient sample is available, hydrolysis can be carried out at reflux, and then, from the hydrolysate, the first few drops are carefully distilled off into a xanthate test, as described by Feigl (5), to detect the presence of alcohol. Formaldehyde does not interfere, but the test is not sensitive.

With color development using Scarlet 4RA, tests are not affected by nitrogen-containing fibers, such as wool, nylon 6 or nylon 66, which give blanks in the absence of resin. Direct and vat dyestuffs do not interfere, but some dye aftertreatments do give positive tests for urea and melamine, and certain waterproofed fabrics also give positive tests, despite the absence of significant crease or shrinkproofing. The amount of amino substance in these cases is well under 1% of fabric weight.

The hydrolysate from tetramethylolacetylenediurea does not form a colored spot under the test conditions as described.

Amino-aldehyde resins have been found on rayon, cotton, wool, nylon and blend fabrics. Their presence in the cellulosics is indicated by higher than normal crease- and shrinkage-resistance, a significant worsening of these properties after 0.1 N hydrochloric acid hydrolysis, loss of HCHO during the hydrolysis, and significant Kjeldahl-test nitrogen in the hydrolysis extract. Wool is more shrink resistant and nylon is stiffer when treated with these resins. In many cases, the cellulosics are also stiffened, glazed and pleated with aminoaldehydes.

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Abstracts

Fastness to Rubbing of Azoic Colors

Anon, *Colourage* **3**, 13-14, 48, October, 1956.

Azoic colors are noted for their brilliance of shade and superior washfastness, and are used at present on a large scale. Their principal weakness is a lack of fastness to rubbing, which results from the surface precipitation of particles of pigment that adhere loosely to the fiber.

Various workers have investigated the problem. It has been shown that the fastness to rubbing is affected by the physical structure of the fabric, and that it can be improved by using techniques that give better penetration of the dye. It has also been shown that any Naphthol not actually combined with the fiber (ie, held mechanically only) will impair the rubbing fastness of the resultant dyeing. It was recommended to extract the goods thoroughly after impregnation with the Naphthol, and to add salt to the impregnating liquor; also an intermediate rinse with salt, to remove loose Naphthol, and an intermediate drying were advocated.

For satisfactory coupling of the dye, it is necessary to neutralize any alkali that has been carried along with the goods, by the addition of alkali-binding regents.

The final soaping should be carried out at as high a temperature as possible. The presence of iron in the wash-water is said to affect the crockfastness considerably.

The author refers particularly to the work of the AATCC Piedmont Section's Intersectional Contest Committee for 1955 (reported in the ADR May 7, 1956), on the effects of a number of variables in azoic dyeing on the resultant crackfastness. They reported that there is no simple cure for crocking. They found that some Naphthols give much better crockfastness than others, and that the fastness varies widely with different finishing treatments. They recommended for the final soap boil the use of alkaline soap in preference to synthetic detergents.—WHC

Comparison of Wrinkle-Resistant Finishes for Cotton

Cooke, T F *et al*, *Textile Research J* **27**, 150-65, February, 1957

A brief description is given on the mechanism by which wrinkle-resistant properties are imparted to cotton fabrics by the use of urea- and melamine-type resins. A summary of the chemistry of these products is given. The results of an extensive study of the application of urea, modified urea (ethylene urea), melamine, and modified melamine formaldehyde resins using ammonium, alkanolamine and metallic inorganic salt accelerators to cotton fabric are presented. The effect of variations in resin concentration, curing temperature and time on the wrinkle recovery, tensile strength, tear strength and discoloration of the treated fabric before and after washing is discussed.

This work was designed and analyzed statistically to ensure an accurate and authoritative presentation of the more important properties imparted to cotton fabric for the systems studied. These data should enable a cotton fabric finisher to select the optimum resins and conditions of application to obtain the wrinkle-resistant finish best suited for the specific fabric properties desired.

Following is a brief summary of the physical properties of the finishes studied:

The ethylene urea (EU) finishes generally have the highest wrinkle recovery for a given resin solids, and the urea-formaldehyde (UF) the lowest. The melamine finishes are intermediate, with the modified melamine formaldehyde (MF) equalling the EU under optimum curing conditions.

The retention of wrinkle recovery through chlorine washing of the melamine finishes is considerably greater than that of the EU or UF.

The MF and UF finishes generally have higher tensile strength than those of the modified MF and the EU finishes for a given wrinkle recovery.

The EU finished fabric generally shows a gain in tensile strength on continued chlorine washing. The melamine resin treated fabrics show little loss in strength on continued washings, while the tensile strength of the UF treated fabric decreases rapidly.

Of the accelerators employed, magnesium chloride was rated the best, and ammonium sulfate the poorest. An alkanolamine hydrochloride was inferior to magnesium chloride in most respects, but its optimum curing temperature was lower.

Nine references to the literature are cited.—WHC

Smog: Its Effect on Dyes and Textiles

Fibres (Engineering and Chemistry) **18**, 39, February, 1957

As fast as dye makers and dyers together make progress in producing colored textile materials having increased fastness to a wide variety of deteriorating conditions, so do the changing circumstances in crowded cities make it the more necessary for fast colorings to be produced. Hitherto, colored textiles have been required to be fast to such influences as light, washing, heat, chlorine, acids, alkalis, etc, but it has now become definitely necessary to add a fastness to smog.

Not all the ingredients of smog which cause eye irritation, reduced visibility, odor, breathing difficulties, etc, have been identified, but they are already known to include hydrocarbons, nitrogen dioxide, sulfur dioxide, aldehydes and organic acids, most of which can attack both fibers and dyes.

London is not the only city to suffer from smog; it is especially prevalent and harmful in Los Angeles, and today research is being carried out there, to determine the fastness of dyes and dyeing to smog. The tests involve exposure, within cabinets not penetrable by sunlight but freely open to smog, of colored acetate, nylon, cotton, wool, viscose rayon and Orlon materials (all types of dyes were used in their coloring), and from time to time fiber deterioration and color changes are measured photometrically and visually. Already color changes have occurred, but the tests are not yet sufficiently prolonged to justify exact conclusions as to the effect of smog on fiber strength; these will be published in due course.

A significant feature concerned with the contaminants of a smog-laden and a smog-free atmosphere is that when smog is prevalent the air contains the usual proportions of carbon monoxide and sulfur dioxide but appreciably increased proportions of oxidizing impurities, especially ozone, which is well known to be particularly harmful to textile fibers. —WHC

Theory of Dyeing Polyester and Polyacrylic Fibers

Remington, W R and Schroeder, H E, *Textile Research J* **27**, 177-85, March, 1957

Polyacrylonitrile fibers are dyed with anionic and cationic dyes, if sites are present. They can also be dyed with disperse or nonionic dyes.

Ionic dyes require sites. It has been found possible to provide sites through modification of the polyacrylonitrile, either in its preparation or after it has been converted to a fiber. Thus, copolymerization of acrylonitrile with vinyl pyridine affords basic groups which act as cationic sites for the dye anions. Equilibrium dyeing studies confirm this picture. In fibrous forms polyacrylonitrile can acquire cationic sites through treatment with cuprous salts which are believed to form complexes of the type RCN→Cu with cyano groups in the fiber. The fiber is then colored by an ion exchange reaction involving replacement of colorless anions by the more affinitive dye anions. A similar general picture for salt formation on anionic sites exists for absorption of dye cations.

In contrast, disperse dyes, which are used on all common fibers except cellulose and wool, require no specific dyeing sites. In the case of polyethylene terephthalate, a study of the equilibrium partition of pure dyes between the fiber and aqueous solution gave a straight line plot characteristic of a process of simple solution. The dyeing reaction therefore involves simple solution of dye in the fiber. In mixtures of dissimilar dyes, the individuals are absorbed independently as though the other compound was not present. Although the fiber cannot have specific sites for the dyes, there are probably significant dipole-dipole interactions between dye molecules and the polymer chains.

The rate of dyeing of polyethylene terephthalate tends to be inconveniently slow under ordinary dyeing conditions, but can be accelerated by increase in temperature or the use of organic compounds called "carriers". These generally aromatic molecules are effective by increasing the diffusion rate of dye through the fiber. Their effect is shown to be independent of carrier structures, but proportional to the number of moles of carrier dissolved in the fiber.

Fourteen references to the literature are cited.—WHC

Cotton Bleaching and Dyeing Wastes: a Specific Solution and a General Prescription

Hart, W B, *Ind Eng Chem*, March, 1957, 81A-82A

The author discusses the wastes from the various operations of cotton bleaching and dyeing, and makes recommendations for their treatment. He points out that the wastes to be corrected usually are water solutions of caustic soda, sodium carbonate, soaps or detergents, sodium silicate, peroxide, sodium sulfate, wetting agents, and compounds designed for special purposes of treatment. Sulfuric acid is used also, but not in great quantity.

These bleaching and dyeing wastes are a problem in treatment and disposal. Not only their composition but the irregularity of occurrence make the handling of wastes from bleacheries, and the dye houses which usually are associated with them, one of the most difficult in all the waste-treatment problems of industry.

The first step in the correction of the bleachery wastes is the reduction of the pH to a level that will not interfere with later biological treatment. This reduction requires the introduction of an acidic compound to neutralize to the pH level desired. For a cheap acidic compound, the author proposes using boiler-house stack gases, and discusses the equipment that would be required. Colored wastes usually need treatment with chlorine. The author makes various suggestions for handling these wastes, by aeration, filtration, etc.

In the dyehouse, sulfur dyes give a waste carrying a high concentration of suspended dye material. Other dyes produce highly colored wastes. The author states that wastes of this nature can be corrected by flocculation, followed by biofiltration for reduction of the biochemical oxygen demand. Intermediate between the flocculation treatment and the biofiltration, a lift-type air clarifier will be very helpful, the author states, in removing the suspended matter, which then can be collected and burned.

The author concludes that there is great opportunity for research on these wastes, and development of processes that will be more adaptable to wastes which vary in composition, and can be provided at lower cost. —WHC

The Soiling Characteristics of Textile Fibers. Part II: The Influence of Fiber Geometry on Soil Retention

Weatherburn, A S and Bayley, C H, *Textile Research J* **27**, 199-208, March, 1957

In Part I of this series (*ibid* 25, 549-58, 1955) some of the factors that contribute to the soiling of textile materials were discussed, and a method was described for measuring the "effective soil content" of soiled fibers. In the present paper, an attempt has been made to show the relation between soil retention and various physical characteristics of the fibers.

The influence on soil retention of filament denier and cross-sectional contour of a series of man-made fi-

(Concluded on page 336)

Proceedings of the
American Association of Textile Chemists and Colorists

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May 6, 1957

AATCC Calendar

COUNCIL

June 7 (Hotel Statler, New York)

NATIONAL CONVENTIONS

Nov 14-16, 1957 (Hotel Statler, Boston); Oct 30-Nov 2, 1958 (Hotel Conrad Hilton, Chicago); 1959 (Sheraton Park and Shoreham Hotels, Washington, DC); Oct 6-8, 1960 (Sheraton Hotel, Philadelphia, Pa); September 28-30, 1961 (Buffalo, NY)

DELAWARE VALLEY SECTION

May 24 (Outing—Torresdale-Frankford Country Club, Philadelphia, Pa); Sept 27 (Joint meeting with New York Section at Hotel Hildebrecht, Trenton, NJ); Nov 1 (Sheraton Hotel, Philadelphia, Pa); Dec 6 (Kugler's Restaurant, Philadelphia, Pa)

HUDSON-MOHAWK SECTION

May 17 (Ladies Nite—Schuyler Meadows, Albany, NY); June 21 (Outing—Antlers Country Club, Amsterdam, NY)

MID-WEST SECTION

June 14-15 (Outing—Brown's Lake Resort, Burlington, Wis); October 26 (Bismarck Hotel, Chicago, Ill)

NEW YORK SECTION

May 24 (Ladies night—Kohler's Swiss Chalet); June 21 (Outing—North Jersey Country Club, Wayne Twsp, NJ); Sept 27 (Joint meeting with Delaware Valley Section at Hotel Hildebrecht, Trenton, NJ)

NORTHERN NEW ENGLAND SECTION

May 10 (Lowell Tech Inst, Lowell, Mass); Sept 13 (Outing—Wachusett Country Club, W Bolyston, Mass); Dec 6 (Annual meeting, Hotel Continental, Cambridge, Mass)

PIEDMONT SECTION

June 7-9 (Outing—Mayview Manor, Blowing Rock, NC); Sept 28 (Hotel Barringer, Charlotte, NC)

RHODE ISLAND SECTION

June 14 (Outing—Warwick CC and Rocky Point, RI); Sept 27 (Ladies Night—Narragansett Hotel, Providence, RI); Oct 24 (Providence Engineering Society, Providence, RI); Dec 5 (Annual Meeting—Johnson's Hummocks Grill, Providence, RI)

SOUTH CENTRAL SECTION

June 21-22 (Outing—Lookout Mtn, Tenn); Sept 20 (Hotel Patton, Chattanooga, Tenn)

SOUTHEASTERN SECTION

June 7-9 (Outing—Radium Springs, Ga.); Sept 14 (Harmony Club, Columbus, Ga); Dec 7 (Dinkler Plaza Hotel, Atlanta, Ga)

WESTERN NEW ENGLAND SECTION

May 17 (Ladies Night—Rapp's Paradise Inn, Ansonia, Conn); June 14 (Outing—Wallingford, Conn); Sept 27 (Rapp's Restaurant, Shelton, Conn); Nov 1 (Annual meeting, Hartford, Conn, area); Dec 13 (Rapp's Restaurant, Shelton, Conn)

MEMBERSHIP APPLICATIONS

SENIOR

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Brooklyn Harris—Mgr & textile analyst, Western Lab, National Inst of Drycleaning, Glendale, Calif. Sponsors: J R Wiebush, R T Graham. (PS)

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TRANSFER TO SENIOR MEMBERSHIP

Harry L Parker

AATCC NEWSLETTER...

MAY 6, 1957

RESEARCH NEWS IN GENERAL:

AATCC Council appropriated $2,000 (to which will be added $500 from the Piedmont Section) to finance a new research study of present and potential uses for radiochemicals in the textile wet-processing industry. . . . The study will be conducted by the Piedmont Section, under direction of Luther B Arnold, Jr, the Section's Research Committee chairman. . . . Attention was focused on this subject at the Section's recent meeting in Roanoke, when Irving Berstein, Tracerlab, Inc, spoke on "Applications of Radioactivity in the Textile Industry." . . . This paper was followed by a special meeting of AATCC's Technical Committee on Research, presided over by Charles Sylvester, TCR chairman. . . . George S Wham spoke for the Wash and Wear Committee; Ralph B Smith for the Colorfastness to Washing Committee; Joseph E Norton, Colorfastness to Light; Richard F Aurich, Damage Caused by Retained Chlorine; and John H Warner, Dimensional Changes in Textile Fibers. These reports will be published shortly in the Proceedings.

Charles Dorn, ECR chairman, reported to Council at the March 29 meeting that ECR had agreed to go ahead (in cooperation with the National Retail Dry Goods Association) with an exhibit on flammability of textiles, to be set up in the Department of Commerce building in Washington. . . . ECR also approved the changing of Test Method 23-54 (Atmospheric Fading from Nitrogen Fumes) from a tentative to a standard test method.

NEWS FROM RESEARCH HEADQUARTERS:

Federal government departments will be provided with a cross-index of the old prototype and new Colour Index numbers of dyestuffs, so that they can be used in future government statistical reports, Mr Dorn said. . . . ECR voted to discontinue the sale of continental (cloth) gray scales, because these were held to be not uniform. . . . ECR also affirmed as an AATCC research policy that requests for work by members of the Lowell staff on research committee projects must be made through the director of research. . . . Research committee appropriations voted by Council (in addition to the $2,000 for radiochemical study) included $1,000 for the Committee on Retained Chlorine and $1,600 for permanent equipment (conditioning equipment).

COMMITTEE NEWS:

Lindsay V Chase, of Interchemical Corp, was approved as a member of TCR. . . . The Abrasion Committee is currently running a series of inter-laboratory tests with the Accelerotor, with respect to abrasion of cotton twills, sheetings and rayons. This study includes resinated and unresinated fabrics. . . . Big crowds were drawn to AATCC's exhibit at the recent Lowell Technological Institute Open House April 5 and 6. The Association exhibit featured material explaining what AATCC is, what it does, and how, in the area of testing.

Results of recent balloting on the proposed Standardization of Methods for Evaluating Colorfastness Tests indicate the proposition has been approved, according to Dr Stiegler at Lowell. . . . Albert Johnson, chairman of the Committee on Dry-cleaning Test Methods, reports that the Committee has completed its research work connected with colorfastness to drycleaning, and is expected to make its report shortly. The report, Mr Johnson said, will also include recommendations for a test to determine the durability of finishes in drycleaning.

South Central Section———

RECENT DEVELOPMENTS IN VAT DYEING*

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Technical Laboratory
E I du Pont de Nemours & Co, Inc
Wilmington, Del

Developments in the application of vat dyes that have taken place during the last ten years in the various segments of the textile industry are discussed. In the cotton piece goods field, the Du Pont Pad-Steam Continuous Dyeing Process and the Williams Unit have made a tremendous impact. The Savagraph Process for printing vat dyes is the latest development in printing. High temperatures are being used by the package dyers, and those vat dyes suitable for application at 230°F are listed. Cotton socks, knit goods and scatter rugs are being dyed with vat dyes. The Du Pont Flowstock Process, a new continuous process for dyeing cotton or rayon staple fibers with vat dyes, is described. The Flowstock Process is also applicable to wool and nylon.

INTRODUCTION

I WOULD like to discuss with you some of the recent developments in vat dyeing. Let us look back only ten years and see what has happened in this short period.

The housewife and the buying public have become more and more conscious of the value of vat dyes in the cotton and rayon fabrics they wear and use. For example, this color consciousness is reflected here in the Chattanooga area where you are This trend has been particularly noticeable in the last ten years.

The consumption of vat dyes has increased steadily over the past ten years as the figures in Table I indicate.

This increase has been due to your desire to give your customer a better product, his appreciation for a better product, and improved methods of application.

As we look at the various segments of the great textile industry you will realize what tremendous strides have been made. It is also readily apparent how one segment of the industry influences another technically.

DISCUSSION

COTTON PIECE GOODS——— Prior to 1946 almost all vat dyes were applied to cotton piece goods by the pigment pad-jig reduction method or by the reduced pad-continuous booster method. The pad-jig method was a batch operation and as such had its limitations. The continuous booster method was cumbersome and was restricted to use in a few plants where large yardages of a single shade were to be produced. Its advantage was that it was a continuous operation, and once it was set up it had a good production rate. Its main disadvantages were: 1) the minimum economical yardage was twenty to thirty thousand yards, 2) the depth of shade was limited to medium shades, 3) shades were difficult to establish, and 4) the booster held one thousand to three thousand gallons of dyebath containing chemicals and dye which made it costly just to prime the booster.

*Presented before the South Central Section in Chattanooga, Tenn on Dec 1, 1956. NOTE: Ponsol and Sulfanthrene are registered trademarks of the E I du Pont de Nemours & Co, Inc, Wilmington, Del.

TABLE I
Sales in millions of pounds

	1946	1950	1955
Vat dyes*	30.7	37.5	37.7
Cotton**	4,803	4,680	4,124
Rayon**	397	508	630

*U S Tariff Report
**Textile Economics Bureau

PAD-STEAM———Around the close of World War II there were two new processes introduced for the vat dyeing of cotton piece goods continuously: the Du Pont Pad-Steam Continuous Dyeing Process and the Williams Unit.

The Du Pont Pad-Steam Continuous Dyeing Process consists in padding the dispersed vat dye pigment onto the fabric, drying, padding on caustic soda and Du Pont Hydrosulfite Conc, steaming for twenty to sixty seconds, rinsing, oxidizing and soaping. (See Figure 1). On unmercerized and pile fabrics the drying step after padding can be eliminated. An example of this is in the dyeing of terry towels. I'm sure you are aware of the many beautiful solid shades of vat-dyed towels that your wife can purchase today. Piece dyers have found the pad-steam process to be the most satisfactory from a point of view of quality, economy, high rate of production and, most important, uniformity of shade. Many plants now consider the minimum yardage for a shade to be one to three thousand yards. Compare this with the twenty to thirty thousand yards for the booster method. One pad-steam unit operated by three or four men has replaced about twenty-five jigs and eight to ten men.

A conservative estimate on the number of pad-steam ranges in operation in this country today is well over one hundred and there are many in other parts of the world.

WILLIAMS UNIT———The Williams Unit process differs from the pad-steam process in that a short liquid phase is used for development instead of steam. The cloth is padded with the dispersed vat pigment, dried and passed into the unit containing caustic soda and hydrosulfite where the dye is developed in fifteen to thirty seconds at 190°F. Other units are used to rinse, oxidize and wash. Some plants use a combination of the Williams Unit and a steamer.

MOLTEN METAL———A relatively new English development is the Standfast Molten Metal Machine (*1*). This machine has a U-shaped chamber containing a low melting alloy. On the entering side of the machine there is a pool of reduced vat dye solution, and on the exit side there is a salt bath which prevents oxida-

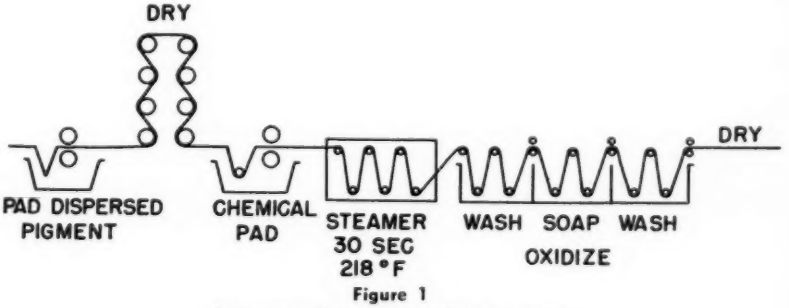

Figure 1
Schematic diagram of pad-steam range

tion of the metal. The fabric enters the reduced dye solution, picks up about 150% (on weight of fabric) of dye liquor, passes down into the molten metal at 190°-200°F for six to eight seconds and out through the salt bath and then through the usual finishing steps. This machine is reported to be easily cleaned and adaptable for short yardages. The small volume of dyebath does not present much of a tailing problem.

BOND MACHINE———The Bond Machine is another recent development for applying vat dyes to piece goods continuously (*2*). It employs perforated plates between which the fabric passes. Dye liquor or vat dye pigment dispersion is pumped at high velocity through the perforations into and through the fabric from each side. Many of you probably saw a model of this machine on display at the AATCC Convention in Atlanta two years ago.

VAT-ACID METHOD———This development came from Europe and was introduced shortly after the close of World War II. In this method the vat dye is reduced with caustic soda, hydrosulfite and a dispersing agent in the usual manner and then added to a bath containing acetic acid. The alkaline leuco is converted to the acid leuco, a fine colloidal dispersion. The vat-acid is padded on the fabric followed by jig development with caustic soda and hydrosulfite or it can be developed by passing the padded fabric through caustic soda and hydrosulfite followed by steaming or Williams Unit development.

The chief advantage of this method over the conventional vat pigment padding procedure is that there is less tendency for the dyes to speck in pastel shades and a somewhat smoother appearance is obtained. Its use is usually limited to pastel shades. It has not proved advantageous for package dyeing.

PRINTING———In many respects the pad-steam method of applying vat dyes to piece goods is related to printing with vat dyes. Certainly vat dye printing had an influence on the development of the pad-steam process. In the conventional printing of vat dyes the dye is mixed with suitable gums, alkali, and a stable reducing agent to form a paste which is printed on the fabric, dried and aged or developed in a steam atmosphere. Under the influence of heat and moisture the vat dyes reduce and are fixed on the fiber.

For a long time we have recognized the desirability of adapting the principles of pad-steam dyeing to the development of vat prints. Recently the Du Pont Company announced the new Savagraph Process for printing vat dyes from a unique water-in-oil emulsion. The prints are dried and subsequently padded with a solution of caustic soda and hydrosulfite and immediately steamed for a short time (twenty to thirty seconds). They are then oxidized and soaped in a continuous open width machine. This process takes advantage of the great increases in strength and broader range of dyes which, in the conventional sulfoxylate printing method, fail to develop full strength and optimum fastness properties.

PACKAGE DYEING———Over the past ten years there has been no one radical change in package dyeing but there have been many improvements.

Equipment

Better package dyeing machines are now available with increased pump flow which has been helpful in obtaining more level dyeings. Stainless steel construction has made cleaning easier and helped to obtain brighter shades.

Better winders for packages and beams have also been of assistance in obtaining more consistent results.

Dryers and extractors are also more efficient and have helped speed up production.

Dyes

Dye manufacturers have improved the dispersibility and particle size of their vat dyes. They have also introduced new dyes that have been accepted by package dyers. A few of the vat dyes introduced by Du Pont in the last ten years are:

Ponsol Yellow 5GLL Paste
Ponsol Red Brown RB Paste
Ponsol Red FG Paste
Ponsol Red RL Paste
Ponsol Scarlet GL Paste
Ponsol Red RRB Paste
Ponsol Direct Black PC Double Paste

DYEING METHODS———The "pigment method" or circulation of the dispersed vat pigment through the package prior to reduction has been used for many years and is now accepted as general practice. Cotton is usually scoured before pigmenting to remove the soluble waxes, pectins, and other natural impurities, thereby obtaining a more uniform deposition of the vat pigment on the yarn during the pigmenting step. Spun rayon packages are usually wet out with the vat dye dispersion by allowing the dispersed dye to seep through the package.

There has been a marked trend toward reduction of vat dyes at temperatures of 180°-190°F instead of the traditional temperatures of 120°-140°F. The higher temperature promotes more rapid development of the dye and leveling is obtained in a shorter period of time. Vat dyes are generally stable in reduction at a temperature of 100°-120°F, but as the temperature is increased to 180°-190°F some dyes become unstable, show a shade change and subsequent decrease in fastness. This degradation can be attributed to a number of causes, including over-reduction and hydrolysis. An example of this is the instability of the chlorine-fast blues which become much duller and greener. With a few dyes, affinity is lowered to such an extent that a poor exhaust is obtained unless the machine is cooled down before dropping the bath.

Considerable work has been done on the problem of stabilizing the vat leuco so it would not be degraded by high temperatures. The Piedmont Section presented a paper in 1948 (*3*) recommending the addition of dextrin to the dyebath for this purpose. Certain types of corn dextrin do an excellent job of stabilizing the vat blues at temperatures of 160°-180°F. As a sidelight, the piece dyers were also having difficulty with the chlorine-fast blues in the Williams Unit, and dextrin solved their problem. Later, Calco suggested the use of sodium nitrite (*4*) and other agents as stabilizers or protective agents for this purpose.

With conventional machines that are not pressurized, it is not worthwhile to go beyond 180°F because, as the temperature is increased beyond this, the pump usually becomes very inefficient because of cavitation. Thus, the gain achieved from another ten or fifteen degrees is more than offset by the loss in circulation.

Temperatures Above 212° F

In 1948 the Philadelphia Section presented a paper (*5*) on dyeing at temperatures above 212°F. It was found that the newer synthetic fibers dyed more rapidly, more uniformly, and with improved fastness properties at temperatures above 212°F. As these fibers became available, the machinery manufacturers started pressurizing the machines so that dyeings could be made at elevated temperatures.

This approach interested the vat

dyers both here and abroad. Several papers have been published in England on this subject (*6*, *7*), and Fox (*8*) discussed this subject at the AATCC Convention in Atlanta in 1954. It has been established, both in the laboratory and in plant practice, that better leveling of vat dyes through the package can be attained at temperatures of 230°-240°F than at temperatures under 212°F. This applies not only to uniformity within the package but also to crossovers on highly twisted yarns which are difficult to penetrate at lower temperatures. The time in reduction can be shortened because of rapid leveling and fixation. When dyeing is carried out in a closed system, there is less loss of hydrosulfite than is normally experienced in an open system. Therefore, somewhat lesser quantities can be used.

It was stated earlier that, as the temperature is increased, we encounter problems of instability of the reduced dye. At temperatures of 230°-240°F this becomes a real problem. A large number of useful vat dyes cannot be used satisfactorily. The number of dyes suitable for application at 230°F is small, but fortunately, a complete shade range is available with the exception of a bright blue. Table II provides a list of Du Pont dyes considered satisfactory for reduction at 230°-240°F for twenty to thirty minutes.

You will note that some of these dyes show a shade change as compared with the 190°F control dyeing. This indicates some degree of instability, and this shade change will become greater as time or temperature is increased.

TABLE II

Effect of temperatures of 230°-240°F on shade

	Shade versus control at 190°F
Ponsol Flavone GCN Paste (Pr 9)	similar
Ponsol Yellow 3R Paste (Pr 452)	app duller
Ponsol Golden Orange G Double Paste (*CI* 1096)	similar
Ponsol Brown RBT Paste (Pr 118)	cons yellower and duller
Ponsol Brown VR Paste	similar
Ponsol Red Brown RB Paste	notc duller
Ponsol Red RRB Paste	cons yellower and duller
Ponsol Red FG Paste	similar
Ponsol Brilliant Violet 3B Paste (Pr 288)	notc duller
Ponsol Violet BN Supra Double Paste (*CI* 1163)	similar
Ponsol Navy Blue Double Paste (Pr 522)	app redder
Ponsol Dark Blue BR Paste (*CI* 1099)	notc greener
Sulfanthrene Blue GR Paste (*CI* 969)	similar
Ponsol Jade Green Supra Double Paste (CI 1101)	similar
Ponsol Green 2BL Paste (Pr 293)	similar
Ponsol Black BN Double Paste (*CI* 1102)	similar
Ponsol Direct Black 3G Double Paste	similar

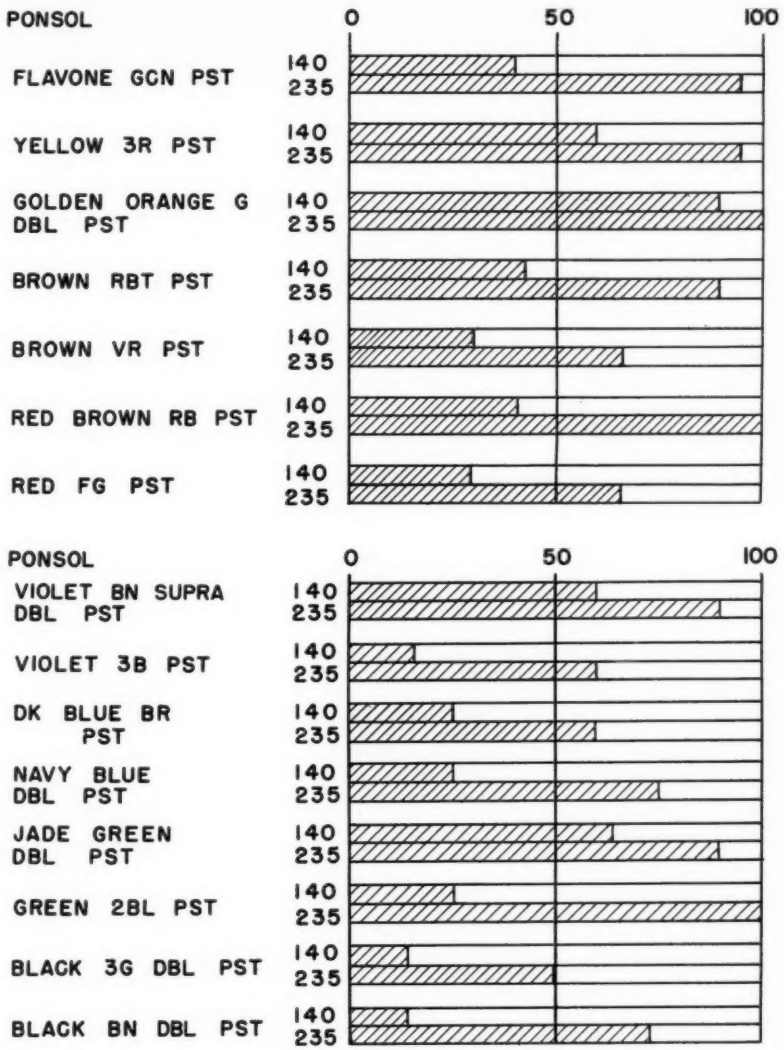

Figure 2
Transfer or leveling of vat dyes on mercerized cotton yarn at 140°F vs 235°F

Considerable effort has been, and is being, devoted toward finding products and conditions which will allow the use of a wider range of vat dyes at higher temperatures. However, results have not been encouraging. For example, chlorine-fast blues, such as Ponsol Blue BF Double Paste (*CI* 1113), can be applied at 230°F for thirty minutes with 3% hydrosulfite, 5% caustic soda and 5% dextrin and still maintain the original shade, but chlorine fastness is sacrificed.

To demonstrate the degree of leveling at 235°F versus that at 140°F, an 8% dyeing was made on two one-half pound packages of mercerized cotton by a conventional method. One of the dyed packages was then reduced with an undyed package for forty minutes at 140°F. The other was reduced at 235°F with an undyed package for twenty minutes with ten minutes needed to reach 235°F and ten minutes to cool. The results of this test with a number of dyes show that some level much better than others, and the high temperature markedly increases leveling. In Figure 2 the original dyed package has been given an arbitrary strength of 100 after the reduction, and the undyed package has, by transfer of color, approached this figure. The nearer the strength on the undyed package to 100 the greater the transfer.

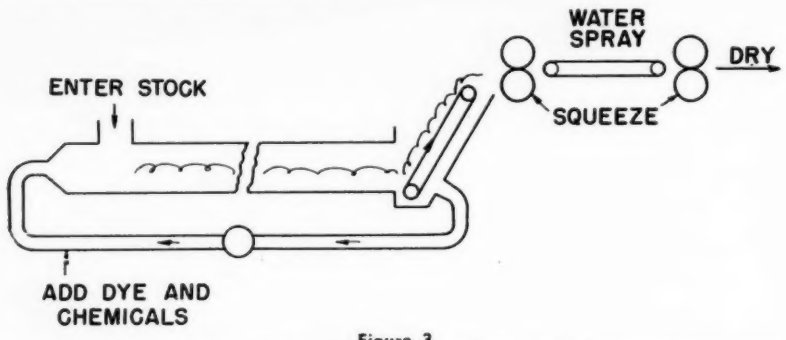

Figure 3

Schematic diagram showing how staple fibers are dyed by the Du Pont Flowstock Process

Summary

The advantages for high-temperature dyeing can be summed up as follows: 1) better leveling, 2) better coverage of crossovers, 3) lower hydrosulfite consumption, and 4) shorter reduction time.

The disadvantages are 1) fewer dyes from which to choose, 2) careful control must be maintained of both time and temperature in reduction above 212°F, and 3) poorer exhaust or utilization of dye is obtained if machine is not cooled before dropping the bath.

Where there is a need for dyeing above 212°F, it can be done quite satisfactorily, but for most work it is not necessary.

KNIT GOODS———Vat dyes are being successfully applied to knit goods in reel machines by pigmenting followed by reduction; however, even the best methods occasionally leave something to be desired. The challenge before us is to develop a continuous method of dyeing knit goods with vat dyes that will be as satisfactory as the pad-steam method for cotton piece goods.

SOCKS———Vat dyes on cotton socks are the rule today rather than the exception they were ten years ago. The methods of applying vat dyes to cotton socks are simple and straightforward. The socks are pigmented at 180°-190°F, followed by reduction with caustic soda and hydrosulfite. There is, however, the possibility that continuous dyeing could be made attractive. It is known that a few of the nylon hosiery concerns are dyeing nylon hose continuously.

CARPETS———The piece dyeing of tufted carpets is an entirely new field. Vat dyes applied to wide carpets on the beck have not yet met with much success and, for this reason, several concerns are working with the newly developed Niptrol padder developed by Rodney Hunt Machine Company. This padder is constructed so that a uniform squeeze is achieved across the width of the carpet. After the dispersed vat dye is padded it is reduced and fixed in a steamer or beck. There are many indications that this method of application will be successful, particularly with vat dyes on rayon and cotton as well as other types of dyes on wool and nylon.

The Burlington High-Press machine has been used successfully for applying vat dyes to rayon or cotton carpets.

RAWSTOCK———The stock dyers are using essentially the same methods as the package dyers. They have adopted the pigment method and reduce at temperatures as high as 180°F to obtain quick reduction and rapid dyeing. The pigment method is almost vital for dyeing rayon stock. The best results have been obtained by wetting out the stock with the dispersed vat dye. The dye liquor is allowed to seep up through the load. After circulation has begun the pigment may be exhausted by the addition of salt, or soda ash and a small amount of hydrosulfite. This is followed by reduction with caustic soda and hydrosulfite.

Rawstock dyeing has always had an advantage in uniformity over package dyeing which results from the blending of several batches so that the whole is one shade. Thus, when the tufted rayon carpet trade demanded vat dyes, one solution to the problem was rawstock dyeing, and that is where the most recent interest has been. Rayon carpet stock is dyed in conventional stock dyeing machines and is easier to dye than the finer denier stock for fabric.

Several years ago Du Pont introduced the continuous method of dyeing wool carpet stock in a wool scouring train and the method has been well received in the trade. After being scoured, the stock enters the dyeing compartment and is moved forward by a series of rakes with the dwell time in the dyebath of ninety seconds. As a unit quantity of stock is added the necessary dye for that quantity is added. Actually, the stock enters continuously so the dye is added continuously.

This method of dyeing could be adapted to the dyeing of rayon carpet stock with vat dyes except for the fact that there is considerable exposure to air and, consequently, consumption of hydrosulfite is almost too great to make it practical. With this in mind, Du Pont has developed the Flowstock Process, which is suitable for the continuous application of vat dyes to rawstock.

DU PONT FLOWSTOCK PROCESS———This development is still in the laboratory stage, but it is so interesting that we want to tell you about it. The laboratory model consists of a glass tube six feet long and two inches in diameter. A pump circulates the dyebath from the entering end of the tube to the exit end. The stock is added and the liquor flow carries it through the tube to the exit end where it is removed. (See Figure 3.) The flow is adjusted to give a dwell period of one minute for rayon carpet stock during which time dyeing takes place at a temperature of 180°-190°F. When vat dyes are applied to rayon carpet stock the bath is made up with caustic soda, hydrosulfite, and enough dye to be at equilibrium. As the stock is added continuously, dye and chemicals are added continuously so that equilibrium is maintained in the system. Thus, for each unit weight of stock added, the amount of dye for that weight is also added. There is a minimum exposure to air and consequently hydrosulfite consumption is very low. Laboratory tests have indicated it to be about three percent, which is in line with other economical processes.

The characteristics of the laboratory model are:

Length	—six feet
Diameter	—two inches
Volume	—four liters
Ratio	—100:1 or forty grams in tube

Rate of flow—variable.

(Concluded on page P328)

Piedmont Section———

BINDERS FOR NONWOVEN FABRICS*

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B F Goodrich Chemical Co
Avon Lake Experimental Station
Avon Lake, O

INTRODUCTION

TO THE general public, nonwoven fabrics appear as a new field in the textile industry. Basically this is not true for felts made of wool or other animal hair have been in use for centuries. These are also truly nonwoven materials. And yet the public is partially correct for the art of producing the modern nonwoven fabrics is relatively new.

As in every field, it becomes necessary to define more exactly the limits of the subject. For this discussion let us say that nonwoven fabrics are textile products in which a binding material provides dimensional stability to a fiber web. Because of the very nature of the product, there has been a strong attempt to use the term "bonded fabrics". Although this does describe the fabrics, the term "bonded" is normally used for laminated materials, such as a fabric bonded to wood or metal. At present, the textile industry in general prefers to use "nonwoven" as the approved terminology and to class felts by themselves.

Nonwoven fabrics as we know them today have been a commercial reality for only about 30 years. In fact, it wasn't until after world war II that any significant amounts of nonwoven fabric were produced. Compared to the centuries during which woven cloth has been produced, this is indeed a short period of time.

In contrast to felts, the new nonwoven fabrics do not rely on any peculiar fiber characteristic (such as the scales on wool) to provide the fabric strength. Thus, virtually any fiber may be used in a nonwoven fabric, as long as a suitable binding material is present. Even glass fibers may be combined into nonwoven products which serve to replace or augment woven glass cloth.

Since, by definition, a binding material is essential for the production of a nonwoven fabric, it would seem that the choice of this binder is as important as the choice of the fiber. Actually one cannot say arbitrarily which is more important. Each particular nonwoven fabric must be judged separately on the basis of its end use. For certain uses many binders may suffice, provided the correct choice of fibers (and web construction) has been made. Conversely, many fibers may serve for a certain end use, if the proper binder system is used.

This discussion will not attempt to go into much detail on what fibers are used and how the web is formed. In fact, we will not even examine *all* of the many binders which can or are being used. Rather, this will be limited to a general summary of the various types of binders and their applications.

CLASSIFICATION OF BINDER SYSTEMS

Just as there is an endless list of uses for textiles, there is an almost infinite number of binder systems which might be used in nonwoven fabrics. While many of these are not commercially feasible with present-day techniques, there still remains a large variety of binders in actual use. In spite of the large number of potential systems, they will all fall into one or more of the following classifications:

1) Solutions
2) Thermoplastic fibers
3) Thermoplastic or thermosetting powders
4) Emulsions

In many cases the binder system will be a combination of two or more of the above classes of materials. Perhaps the simplest thing will be to give a few examples of each class of binder. You who are familiar with textiles or polymers will undoubtedly think of many more along this same line.

SOLUTIONS———Solution binders cover both aqueous and solvent systems. Starch, polyvinyl alcohol, glues, caseins and alginates are all familiar examples of aqueous binder solutions. These are simple to apply, but most will have the disadvantage of being water-sensitive. Sometimes this may be used to advantage. A recent patent (*1*) describes a process in which a fiber pile is supported in an alginate gel, then reinforced with a synthetic resin. After curing, the alginate is washed out, leaving a pile fabric produced without weaving.

Solvent solutions, on the other hand, will produce nonwoven fabrics which are resistant to degradation by water. These solutions may simply act as a carrier for a polymeric binder, eg, a benzene solution of rubber. In this case the solvent is evaporated and the binder remains behind. One of the major problems with such a system is the expensive solvent recovery or elimination equipment necessary and the accompanying hazards.

Although solvents are usually used as carriers for a binder, in some cases the solvents themselves may be used to develop binding by attacking, more or less mildly, the fibers in the web. Here the softened fibers can be pressed together and will adhere when two fibers come in contact. As might be expected, this method requires very close control of the process to prevent excessive damage to the web.

Another example which involves a solution is that of thermosetting resins of the phenolic type, which are used in the binding of glass fiber webs. Generally, these are water-based systems, but they can also be solvent systems.

THERMOPLASTIC FIBERS——— Thermoplastic fibers are used as the binder in many instances. In these cases the bonding usually is effected by passing the web containing the desired amount and distribution of thermoplastic fibers between heated rolls. Depending on the amount of fibers and the nature of the end product, these rolls may be smooth or may contain patterns which will show in the finished product. Polyvinyl chloride, polyethylene or vinylidene polymers and copolymers, polyamide or polyester polymers are a few examples of thermoplastic fibers. Obviously one main requirement is that the binder fiber must soften and flow at a point equal to or below that of the base fiber. Generally this point is well below so that the binder may

* Presented before the Piedmont Section on October 6, 1956 at the Hotel Charlotte, Charlotte, NC.

flow freely to the cross-over points.

The choice of thermoplastic binder fiber cannot be made in a haphazard manner if optimum properties of the nonwoven product are desired. In a recent address, Moffet (2) discussed some work done using fibers made of various thermoplastic materials for bonding nylon and Dacron webs. He found that the best fabrics were produced when the binder fiber and the base fiber were chemically similar. He also found that, generally, the length of the binder fiber was relatively unimportant as long as the total amount remained the same. This assumes that the melted binder will flow to the fiber junctions.

THERMOPLASTIC OR THERMOSETTING POWDERS———Thermoplastic or thermosetting powders provide binding in somewhat the same way as thermoplastic fibers in that the fused polymer holds the fiber web together. Here the powder is dusted into the fiber web either during or after its formation. The actual bonding is produced when the web is passed between heated rolls. This type of bonding is especially useful when the final product is to be compact. Due to the problems in obtaining uniform distribution of the powder throughout the web, this type of binding has not been very popular.

EMULSIONS———The water-based emulsion systems comprise by far the largest class of binders used in nonwoven fabrics. Their ease of handling and general freedom from hazard, as well as the wide range of properties available, have made them especially attractive for nonwoven binding. All of the synthetic latices, such as polyvinyl chloride, polyvinyl acetate, nitrile, polyacrylic, polychloroprene and GR-S types, as well as natural rubber latex fall in this class.

This does not mean that only those materials which are the result of emulsion polymerizations can be used. It is perfectly possible to disperse thermoplastic powders in order to obtain better uniformity in the web. For example, polyethylene, which is not made in a latex form, can be dispersed and deposited throughout the fiber web. Bonding can then be achieved by the application of heat. This technique would not be necessary in most cases, since nearly all of the binder polymers have a latex or emulsion counterpart.

Because of their widespread use, somewhat more information is available on emulsion binder systems. For this reason these systems will be discussed in more detail. The literature is noticeably lacking in information on nonwoven fabrics, especially with reference to binders. This is understandable since, at this stage of the business, those with special knowledge are reluctant to aid others to become active competitors. The few references available usually deal with mechanical methods of producing webs.

DISCUSSION

Most nonwovens of high strength must be made by web saturation or thermoplastic binding. In these cases the actual location of the binder in the finished nonwoven greatly influences the behavior and utility of the product. Where high fabric strength is required at minimum weight, it is necessary that the bulk of the binder be located at fiber junctions. Any binder along the exposed length of the base fibers merely adds weight. In these cases binders of relatively good strength and elongation are used. Brittle materials may be all right provided flexing will be at a minimum.

Where the fabric is to be heat sealed to another surface, it is usually advisable to have a high amount of the binder along the fiber as well as at the fiber junctions. This provides further points for heat-sealing since there is more fiber length than junction points area present on a nonwoven fabric surface.

These are ideal situations and are much easier to discuss than to produce. There are certain basic principles which are of value especially when working with solutions or emulsions. In general, binders which have poor wetting properties will provide more of the binder at fiber junctions. This is caused by the liquid drawing up into drops due to high interfacial surface tension. Those binders which wet readily and flow along the base fiber will also deposit binder at the junction points, but in addition will leave much along the exposed fiber length. These ideal conditions are usually not present in emulsion systems since nearly all will contain considerable amounts of surfactants, which lower the surface tension.

In actual practice, an emulsion binder system is seldom made up of only one type of binder. Although the bulk of the binder may be one type, there are usually auxiliary materials present which may themselves contribute to the binding. For instance, nitrile latex binder systems (which are emulsions) may also contain thermosetting resins and stabilizers, both of which are in the form of water solutions. In another case a thermoplastic resin may do the actual binding after the application of heat; however, this resin may have been applied to the fiber web in the form of a water dispersion or a solvent solution.

No arbitrary statement can be made as to the amount of any one type of binder to be used. Each end use will limit, at least to some extent, the amount of a particular binder which will give optimum results. In the manufacture of sanitary products, very light weight web, usually of oriented fibers, is bonded by a printed pattern of a binder such as polyvinyl acetate. The actual binder covers only a small percentage of the fabric surface (say 10-15%) leaving the product soft and absorbent even though the binder itself is relatively stiff and may be equal in weight to the fiber content. On the other hand, a heavier oriented web could be made into a stiffer liner fabric by a saturation technique which again would result in about a 100% weight pick up, but would be well distributed throughout the web.

One of the major outlets of present industrial fabrics is in the backing for vinyl upholstery. Here again the particular end use will dictate what binder system is used. If the fabric is to be coated or laminated to the vinyl film, the binder must be one capable of producing a strong web which will adhere to the vinyl. For this, polyvinylchloride, nitrile or GR-S latices may suffice. Where the backing is to be sealed by heat or electronically bonded to the vinyl sheet, polyvinylchloride or a blend of polyvinylchloride and nitrile latices is normally used. In both cases the binder would make up 40-60% of the finished product. The combination of nitrile and polyvinylchloride latices is usually preferred, since the nitrile latex will soften the vinyl latex, giving better drape without materially reducing the heat-sealing strength.

A typical recipe for such a product might be a 50/50 blend of the nitrile and vinyl latices with the total solids of the bath reduced to about 20%. In some cases, additional wetting agents or penetrants might be necessary to provide proper web saturation. The saturated web is squeezed to remove excess binder and reduce the solids add on to yield a product of about equal fiber-binder weight. Drying is normally done in hot-air ovens, but may be done on dry cans. In such applications the nitrile latex is usually used without curatives. Webs for this use vary considerably in composition. They

will range from nylon-acetate to rayon-cotton with the latter most common because of cost.

Since many applications of nonwoven fabrics are in garments, the binder must be able to withstand laundering and/or drycleaning. The nitrile latices have found extensive use in these applications because of their good binding properties and their resistance to laundering and drycleaning. When nitrile latices are used in these fabrics, they are usually vulcanized or cured. Normal latex curing recipes are used. The following is typical of a recipe for a nitrile latex.

Nitrile latex	100 parts
Zinc oxide	5 parts
	(all on dry basis)
Sulfur	2 parts
Accelerator	2 parts

Various other compounding ingredients, such as thickeners or stabilizers, antioxidants and wetting agents, may be used if desired.

Although these latices are quite resistant to laundering even though not cured, they must be cured to develop the optimum drycleaning resistance. Further resistance to drycleaning is obtained with certain latices if about 10 parts of a thermosetting resin, such as urea or melamine-formaldehyde, are incorporated into the formulation.

The actual curing of latex compounds can be carried out at much lower temperatures than are required for dry rubber products due to the use of ultra-accelerators. After the fabric is dry, curing can be effected in only a few minutes at 200-220° F. However, when thermosetting resins are used, the curing temperature must reach that necessary to cure the resin—usually 300°-350° F.

PROBLEMS

So far we have discussed mainly the favorable aspects of the nonwoven fabrics. In spite of the tremendous advances which have made during the last ten years, there still are many problems remaining. Some of these are exceedingly difficult to solve. In most cases these problems are related directly to the binders.

One problem is that of fabric strength. While the tear strength of a nonwoven fabric can be made as high or higher than that of a woven fabric on a weight-to-weight basis, the tensile strength is much lower. Woven fabrics can be tailored for strength by changing the base fiber in many cases. In nonwovens this is not true, at least not to the same degree. A nonwoven fabric of nylon will nowhere approach the strength level expected based on yarn tenacity and will not be proportionately higher than one made from cotton or rayon.

The main reasons for this lie in the binder. However, this is not only in the strength of the binder *per se*. Much of the fault lies in the adhesive bond between the binder and the fiber. This is especially true in emulsion systems. In order to have a stable emulsion, each particle must be protected from its neighbor by a layer of a dispersing material. It is only natural that these agents which protect particles from each other can protect the particles from a fiber. The polymer particles naturally have stronger attraction for each other than they do for a foreign material, the fiber. Thus, while there is a strong adhesion between polymer and fiber, it is not as strong as between polymer to polymer.

There is a processing problem which causes difficulties especially during the production of heavy or thick fabrics. This is the tendency of the binder to migrate to the surface of the web during drying. Various techniques have been tried in an effort to reduce binder migration. Their success varies with the type of heating, web construction and binder, so that the answers are still a matter of trial and error.

A condition of low bath solids usually is conducive to binder migration due to the tendency of the escaping water to move the polymer particles. Thus high bath solids may sometimes solve the problem.

It can drying, it has been found advisable to run the first few cans cooler than others and thus bring heat up gradually.

Heat-sensitizing agents, such as polyvinyl methyl ether, have been tried with some success. However, bath stability is affected.

Another novel method of web saturation is covered in numerous patents issued to the Pellon Corporation (*3*). Here the latex is foamed mechanically and then forced into the fiber web. This foaming allows the impregnation to be carried out without soaking the web with excess water.

Another problem which will continue to grow as the apparel usages grow is one of binder resistance to aging compared to its other properties. At present the nitrile latices are most desirable where strength coupled with softness and flexibility are desired. However, although nitrile polymers are relatively resistant to washing, drycleaning and heat and light as regards strength properties, they do discolor under some conditions. Proper compounding can do some good in these cases, but the basic polymer still tends to darken. This is also true of polychloroprene latices, which have the further disadvantages of tendering cellulosics on aging.

Polyvinylchloride and polyvinylacetate materials are much more resistant to yellowing but are also much stiffer and less resilient. When these materials are plasticized to achieve softness, they lose much of their strength and the plasticizer may not be permanent to cleaning.

One answer to some of these problems would appear to be in the acrylate polymers. These are usually completely saturated and as such are highly resistant to discoloration by heat and light. However, these polymers also have many drawbacks. At present they are expensive. They are also less resistant to the action of wet- and drycleaning. Furthermore although they may be quite soft, they lack resilience.

The research groups of many organizations are continually searching for a polymer which will solve these problems. In view of the vast steps taken in these few years, it does not seem overly optimistic to assume that some day such a material will be available.

SUMMARY

We have seen that binder systems for nonwoven fabrics may be grouped into four general classes—solutions, emulsions, thermoplastic fibers and thermoplastic powders. Each has its value and its use will depend on the end use and equipment available. Of these, the water-based emulsion systems are by far the most used because of their ease of handling and safety.

No present binder is by any means perfect. In fact, most of them have drawbacks. The worst problem from an apparel standpoint is the discoloration of the binder systems under heat and light aging. We who are in the polymer industry feel confident that new and different binders will be available in a few years which will allow nonwoven fabrics to become a major portion of the textile industry.

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Piedmont Section———

TECHNOLOGY OF NONWOVEN FABRICS*

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This paper describes briefly the history of nonwoven fabrics and outlines the five basic steps used in the production of these products. A description of the three generally used bonding techniques is included.

A schematic flow sheet highlights the various steps used in making experimental nonwoven fabrics in the pilot plant maintained in the laboratory of the Celanese Corporation. In addition, the five basic objectives of this pilot plant are outlined.

INTRODUCTION

IT IS a pleasure to be able to discuss with you the very interesting and currently popular subject of nonwoven fabrics. I present this to you, not as an authority on the subject, but as one who has been involved in the pilot-plant operation of nonwoven equipment, and one who has been concerned with the sales development of fibers for this use.

It is rather surprising that nonwoven fabrics should be such a popular subject today. As a matter of fact, they are actually used for some of the first clothing. Prehistoric man used skins and leathers, and according to the generally accepted definition, they were nonwovens. The history of modern-day nonwoven fabrics in the United States dates back to the 1930's when thermoplastic fibers were fused together with nonthermoplastic fibers to form fabrics. Around 1945 extensive development was carried out to bind waste fibers with various resins to make fabrics for use as industrial wiping cloth. By 1949 extensive development had started in machine development, new resins and new end uses for nonwoven fabrics. The results of these new developments are the reason everyone is excited about nonwoven fabrics today. Fiber consumption for nonwoven fabrics in 1955 was around fifty million pounds, and it is estimated that it will grow to one hundred and twenty-five million pounds by 1960.

According to *Textile Organon* of August 1956, "Non-woven (or bonded web) textiles are defined as those in which a web or mat of parallel, cross-laid or randomly dispersed fibers is held together by an applied bonding material or by the fusing of self-contained thermoplastic fibers through heat and/or pressure. The difference between non-woven textiles and batting or paper should be noted. Thus battings are not considered nonwoven textiles because of their loft or low density and/or because the fibers are only lightly bonded together. Similarly, paper is not considered as a non-woven textile because it is made up principally of dispersed wood cellulose rather than textile fibers and because it is not truly bonded."

The listing of a few of their advantages may help clarify the term "nonwoven fabrics":

1) In general, they provide a means of converting fiber to a fabric at reduced cost.
2) They provide materials with such performances and functions as elasticity and recovery, porosity, wrinkle resistance, washability, as well as diverse styling effects.
3) They provide means of up-grading staple fiber in waste or categories otherwise considered unsuitable for spinning into yarn.

All three of these are usually involved in the decision to produce nonwoven fabrics; and the emphasis may vary according to the particular situation. One of the oldest nonwoven products, wiping cloths, takes advantage of all three points, low cost, use of off-grade staple, and performance. As filter fabrics, the emphasis is on performance, where random fiber distribution permits lower pressure drop without loss of efficiency. Performance also appears dominant in the use of some nonwovens as backer fabrics for vinyl and other types of plastic films.

In apparel items, nonwoven fabrics offer the possibility of creating new stylings and special performances, such as wrinkle resistance and washability, at reduced cost. The use of waste fibers for apparel does not appear to be practical since the requirements for uniformity and appearance are such that waste fibers usually cannot be used.

DISCUSSION

The properties of nonwoven fabrics are to a large extent determined by the method of manufacturing, the fibers used, and the type of bonding agents employed.

Let's lookinto how nonwoven fabrics are manufactured. Basically, the manufacturing of nonwoven fabrics consist of five steps: opening and blending; web forming; bonding; drying and curing; and finishing.

OPENING AND BLENDING——— The raw stock is prepared on conventional textile equipment with proper opening and blending in order to make the stock suitable for handling in the web-forming process.

WEB FORMING———There are several methods of forming a web for nonwoven fabrics:

1) The oldest and simplest system is that of lining a number of cards, usually from two to six, in tandem where the webs are taken from the doffer combs by an apron that runs under the cards. The web from the back card passes underneath those in front of it to form a composite web. The strength of the web of this sort is predominantly lengthwise and is best suited for applications where strength is needed only in one direction.
2) Another method is that of cross lapping a garnett web. This offers versatility in the weight of webs, widths and types of fibers handled. Lapping processes call for cross lapping the web on a moving conveyer, thus the width can be adjusted by the lap traverse and the weight can be adjusted by the speed of the conveyor. Uniformity of this type web is relatively poor. This system has merit for nonwoven end uses where uniformity is not of prime importance. The strength of this web, of course, is predominantly widthwise. Cards can be and are being used on this system.
3) A third method is a combination of the two methods mentioned above, namely where cards are

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placed in tandem and the cross lapping cards intermittently lapping webs at right angles to form a composite web. This gives a web that has similar length and widthwise strength. This method is especially suitable for end uses where uniform strength and heavier weights are required.

4) The fourth and probably the most desirable method is the "air lay" principal of suspending open fibers into an air stream and collecting the airborne fibers on a moving condenser screen. By this method a completely randum fiber lay is achieved giving a web with equal strength in all directions. The weights are governed by the speeds of the feed and delivery. Webs ranging in weights from one to twenty ounces per square yard can be made.
5) The fifth method is the liquid system. Fibers are suspended in a liquid media and deposited on a porous screen. Paper-making equipment can be and has been used for making nonwoven fabrics, but with textile fibers the major problem is to properly distribute and suspend them. So far these have had to be cut short (¼" or less) to insure proper processing. Uniformity and a high rate of production are intriguing fixtures of this technique, although for nonwoven fabrics it is much less developed than the methods mentioned above. The disadvantages of having to use fibers with lengths of ¼" or less is obvious.

BONDING———There are three basic bonding techniques for nonwoven fabrics:

1) Saturation bonding is probably the most common method in use to date. This can be done in several ways. The dry web may be passed between two horizontal rollers where the bonding agent is applied to the web as it goes into the nip of the roll and compressed into the web. Another method which is most common for randum webs is that of passing the web between two supporting screens or perforated cylinders into a resin bath. After the batting is completely saturated, the excess binder is usually removed by squeeze rolls or vacuum system. Another system, still under development, is the use of sprays. Here the web is saturated by spraying on the resin with a series of reciprocating sprays in order to get complete saturation. The excess binder is removed in a way similar to that in the system mentioned above, that is, by squeeze rolls or vacuum.
2) The second method is spot bonding, where bonding agents are more or less printed in an intermediate pattern on the web. This produces a fabric with excellent drapeability and softness of hand, but it is limited to end uses where durability is not of prime importance.
3) The third method of bonding is by the use of low-melting-point thermoplastic fibers. Thermoplastic fibers are blended into the web at the initial operation and bonding is achieved by passing the dry web through controlled heat and pressure.

Celanese Corporation has done extensive development on low-melting-point plasticized acetate fiber for this end use. We have found that, by incorporating plasticizers into our conventional acetate, we can lower the melting temperature to almost any degree desired, depending on what type and how much plasticizer is used.

Table I shows the results of bonding-temperature tests conducted on four acetate-fiber samples containing varying amounts of Santicizer 8 and dimethylphthalate plasticizers. Samples were prepared by hand carding the fibers, which were one inch in length (2.5 to 3 dpf), and forming a disk ½" in diameter and 1/16" thick. This method employed the Parr-Dennis type melting-point apparatus. Seventy milligrams of carded yarn samples were inserted in the mold and a jig peg was used to prevent the yarn sample from being pressed to the bottom of the mold. The mold was then placed on a heating element and a steel rod pressed the sample against the heated surface. Samples were allowed to remain on the heating element for ten seconds and then examined when removed from the mold. Since bonding conditions encountered in actual practice vary considerably, these results can only be used as an indication of the bonding temperatures of these particular fibers.

For some applications, plasticized fibers are rather expensive. New methods are being developed to apply plasticizers by spray equipment at the web-forming stage. Table II shows a list of plasticizers that we have found to work successfully on secondary acetate and triacetate.

DRYING and CURING———Drying and curing of the saturated web is accomplished by conventional textile methods with little variation. Hot-air dryers and steam-heated cans are among the most commonly used. Of course, the type binders more or less govern the method of drying to be employed.

FINISHING———Up to now, most nonwoven fabrics have been sold in the greige. Nevertheless, nonwoven fabrics can be printed, embossed, cut, stitched, dyed, or in many ways processed in the same manner as woven fabrics. Considerable work is being done presently on finishing techniques for nonwoven fabrics.

Many of the nonwoven fabrics, particularly those going into household furnishings and the apparel applications, will require the same type of chemical finishing treatments as will woven fabrics when it is desired to impart water repellancy, fire retardency, mildew resistance, antistatic protection, etc. The specific finishing requirements will be determined in part by the fibers involved and the particular end-use applications. Where cutting and sewing are required, attention must be given to the application of a lubricant or softener to minimize fusion and reduction in seam strength.

Although the chemical principles developed for woven fabrics can be applied to nonwoven fabrics, the

TABLE I

Results of bonding-temperature tests on various acetate-fiber samples

Sample	Plasticizer Type	Plasticizer	Bonding-point temperature (°F) No bonding but retains form	Very slight bonding	Definite fusion
1	25%	Santicizer 8	240–250	260–280	290–300
2	35%	Santicizer 8	210–220	230–240	250–260
3	25%	Dimethyl-phthalate	250–260	270–280	290–300
4	35%	Dimethyl-phthalate	220–230	240–250	260–270

TABLE II

Active plasticizers for acetate and Triacetate

Dimethylphthalate
Dimethoxyethylphthalate
Diethoxyethylphthalate
Dicyclohexylphthalate

Toluene sulfonamide
Toluene ethylsulfonamide
Ethylphthalyl ethyl glycolate
Diethyl adipate
Diethyl tartrate

Dibutyl tartrate
Ethyl benzoate
Triethyl citrate
Glycerol triacetate
Diethyleneglycol diacetate

mechanical handling in padding, drying, and framing will have to be adapted to the properties of the nonwoven fabrics, and new procedures will have to be developed.

Because of the rapidly accelerated interest in nonwoven fabrics, and since Celanese is convinced that its fibers can play an important role in the development of these products, a nonwoven products pilot plant has been established within the Applications and Product Development Department. Although this equipment is not designed for the production of specific nonwoven products, it can be considered as representative of nonwoven operations having commercial counterpart. Figure 1 shows schematically the pilot-plant operation and some of its equipment.

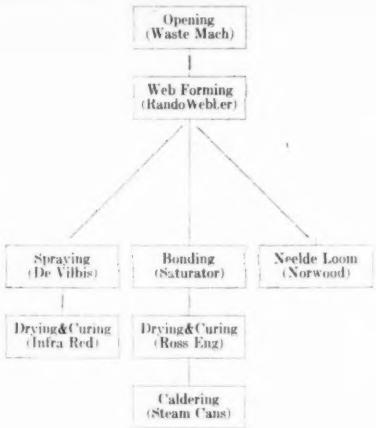

Figure 1

What is this pilot plant designed to do? Briefly, it was established to accomplish the following:

1) To obtain basic data on nonwoven fabrics. This includes the study of the effects of various chemical .bonding agents and thermoplastic fibers; the role of fiber, lengths, denier and cross section of such Celanese fibers as Arnel, acetate, Fortisan, Fortisan-36 and rayon will be studied. In addition, basic data will be obtained from the use of blends of all fibers.
2) To develop products to specifications. The use of the equipment and know-how obtained from the pilot plant operation to make products with established specifications from our fibers will constitute an important phase of the operations.
3) To furnish service to potential customers. This will involve the making of various nonwoven products from our fibers and others at the suggestion and request of our customers.
4) To help solve customers' problems or eliminate complaints on operating difficulties that may arise due to lack of know-how resulting from the use of our fibers and others will be investigated and solutions attempted, based on trial runs and other development work.
5) To cooperate with manufacturers of bonding agents. Samples will be made and development programs undertaken in cooperation with the manufacturers of bonding agents.

Though the dyeing and finishing of nonwoven fabrics is an extremely new art, a program has been established so that basic information can be gathered with regard to the coloring and finishing of nonwoven fabrics.

SUMMARY

We have indicated that, although nonwoven fabrics were one of the first textiles used, it has only been in the past few years that accelerated interest has been aroused. The making of nonwoven fabrics involves five major steps: opening and blending, web forming, bonding, drying and curing, and finishing.

Finally, we at Celanese agree that nonwoven fabrics involving the use of our fibers have a promising future, and have geared our sales and development activities to take advantage of this trend.

ACKNOWLEDGMENT

The authors wish to express their appreciation to Dr A F Tesi for his assistance in the editing and organizing of this speech; and to Dr R G Stoll for his making available information of the operations and objectives of the pilot plants on nonwoven fabrics.

Vat Dyeing———

(Concluded from page P322)

A full-scale machine could have the following characteristics:

Length	—twenty-five feet
Diameter	—two feet
Volume	—600 gallons
Ratio	—100:1 or fifty pounds in tube

Rate of flow—variable.

With a dwell time of one minute, fifty pounds of stock is fed per minute and dyed at the rate of fifty pounds per minute or 3000 pounds per hour. If a longer dwell time is needed for wool or nylon, the pump can be slowed down to give a dwell time of three minutes or a production of 1000 pounds per hour. Since this is a continuous process, the rate of flow must be constant and the dye must be fed continuously in exact ratio to the feed of stock.

The dyeing conditions in this new process for vat dyes are closely related to those used in other continuous systems. However, dyes must be used that have a good degree of stability at 180°-190°F. Dyes such as the chlorine-fast blues have to be run at 160°-170°F with the use of stabilizers, such as dextrin. In dyeing wool or nylon the conditions are exactly like those presently used in the scouring train except that there will be considerably less heat loss. Other processes may be carried out in this type equipment if the required time is relatively short.

SUMMARY

Developments in the application of vat dyes in the last ten years have been highlighted to show how one part of an industry can influence another. Progress has been impressive, and it is attributed to the cooperative efforts of the dyers and finishers, the dye manufacturers and the machinery builders.

As the ultimate consumer becomes more aware of the lasting satisfaction received from vat-dyed fabrics, the demand for vat dyes will be increased. There is every reason to expect we will make as much progress in the next ten years as we have in the past ten years.

ACKNOWLEDGMENT

The author wishes to acknowledge the contribution of G T Hug of the Du Pont Technical Laboratory to the development of the Flowstock Process.

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THE TEAR STRENGTH OF FABRICS

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The tear strength of fabric is determined by the tensile strength of its load-bearing elements and the way the tearing load is distributed over these elements. The distribution depends on the geometry of the load application and the response of the fabric to the distorting forces involved. Load distribution is discussed for three common tearing tests—the trapezoid, Elmendorf and tongue methods. The distortion of the fabric is least important in the trapezoid test and most important in the tongue test.

The effect of examples of three classes of finishing agents on tear strength as measured by these three tests has been studied. Long-chain alkyl quaternary salts, which are surface lubricants, increase tear strength when it is measured by a test emphasizing the response of the fabric to distorting forces, such as the tongue test. Aminoplast resin precondensates, which are reacted within the individual fibers, reduce the tensile strength of fabrics and the tear strength is reduced proportionately in all three tests. These materials seem to have no effect on fabric distortion. Surface resins, however, do produce such effects and may change the tear strength either up or down, depending on the relative mechanical properties of the resin and the fabric structure, and on the tear test that is used.

INTRODUCTION

A very common cause of the service failure of fabrics is lack of resistance to tearing. This has been of particular concern to the Quartermaster Corps, which has supported much research in this field, and also to finishers who want to apply thermosetting resins to cotton fabrics. In the Quartermaster's work, most attention has been given to the relation of tear strength to yarn and fabric construction, while the finishers have been most interested in finding finishing agents which would minimize the tear strength loss on a given construction. Some relationships important in the latter respect are discussed in this paper.

A tear can be defined as a rupture caused by catching a moving fabric on a sharp object, which is sufficiently fixed in position to exert a tensile force on the fabric as it is moved away. The resistance to a force applied in this way is not simply related to the tensile strength of the fabric because the average load during the tear depends on the amount of deformation of the fabric structure which can occur. This deformation determines the number of load-bearing elements over which the total tearing load is distributed. If the yarns in the fabric are packed relatively tightly or are immobilized by a heavy finish, little distortion can occur during the tearing action. In this case, the yarns are broken one by one and the average tearing load is low. If the fabric construction and finish allow considerable slippage of the yarns, the latter slide together as the fabric tears. The result is that they reinforce one another and must be broken in groups, so that the average tearing load may be several times higher than for a nondeformable fabric.

Three test methods are in common use at present for evaluating the tear strength of fabrics—the trapezoid tear test, the Elmendorf tear test, and the tongue tear test.

TRAPEZOID TEAR TEST——— The trapezoid tear test (*1*) is carried out with a rectangular sample on which a trapezoid is laid out. A small cut to start the tear is made in the short side of the trapezoid. The sloping sides of the trapezoid are clamped in a pair of parallel jaws and a load is applied in the direction normal to the jaw edge. A tear begins at the cut and is propagated across the sample. The tester, which should preferably be of the autographic type, measures the average tearing load required to propagate the tear, although the determination of the average tearing load from the autographic record is not unambiguous, as Turl (*11*) has pointed out. The origin of the trapezoid test appears to be rather obscure. According to the references cited by Millard *(5)*, a test of this type was in use during World War I among workers studying the properties of doped aircraft fabric. The acute angle of the trapezoid then used was larger than the angle in the present standard test. The tear produced in this test simulates very closely the type of failure observed in fabric tightly stretched over an aircraft frame, or the sort of failure which would generally be described as a split. The trapezoid test has been analyzed theoretically by Hager, Gagliardi and Walker (*3*) and Steele and Gruntfest (*9*)

ELMENDORF TEAR TEST——— The Elmendorf tear test was originally developed for measuring the edge tear resistance of paper and is carried out on a special pendulum-loaded instrument. A rectangular sample is used with a cut in one side. The two tails thus formed are gripped in the jaws, one of which is fixed while the other is attached to the pendulum. The sample is placed in the jaws with the pendulum raised. When the pendulum is permitted to swing down, the jaws separate, the sample is torn, and the work consumed in tearing the sample is determined by measuring the retardation of the pendulum. This test has been used extensively on fabrics only since World War II. Its use in this field has been discussed by Painter, Chu and Morgan (*6*), who studied in detail the speeds of tear obtained with the Elmendorf tester.

TONGUE TEAR TEST——— The tongue tear test also tears a rectangular sample in much the same fashion as the Elmendorf test, except that the test is carried out on one of the usual types of tensile testing instruments at a considerably slower speed. When a sensitive autographic instrument is used, such as the Instron tester, either the average tearing load, the average maximum tearing load, or the work of tearing can be determined from the chart record. Turl (*11*) has pointed out that various official directions for this test give different procedures for evaluating the test result from the chart. Krook and Fox (*4*) and Texeira, Platt, and Hamburger (*10*) have analyzed this test procedure and discussed in detail the role of fabric geometry in the results obtained.

In each of these tests, it is obvious that both yarns and fibers are ultimately ruptured and that the measured tear resistance will be a function of the strength of these fabric components. However, the circumstances of the tear can have a considerable effect on the number of these stress-bearing elements which can contribute to the resistance to the tearing load. This number is particularly affected by the geometry of the application of the tear load and the response of the fabric in redistributing the applied load as a result of its deformability. This distortion depends very much on the fabric

construction and finish. Since deformability is important in the tearing behavior of fabric and since it is not easily characterized by other tests, as yarn or fiber strength is, it would appear that the most informative tear test would be one which emphasizes this factor as much as possible.

Various types of deformation can occur in a fabric when it is torn (*10*). For example, when an edge tear is begun in a fabric and made to continue by pulling apart the sections of the original edge which were adjacent, as in the tongue or Elmendorf tests, the following forms of fabric distortion can occur: 1) the cross-yarns pull out of the fabric and become the locus of the tear, 2) crimp is removed from both sets of yarns near the tear locus and crimp interchange may occur in the untorn fabric, 3) the yarns just ahead of the locus of tear slip over each other and become jammed together, and 4) on either side of the tear site, the yarns are involved in what is called pantograph or trellis distortion. All these actions are obviously very much influenced by geometrical factors of the fabric construction, the nature of the fibers, and the finish that may be applied.

In the trapezoid test, each yarn involved in the tear is clamped in the tester jaws at each end, in its original position in the fabric. As the jaws are moved apart, relatively little distortion takes place. The yarns are, for the most part, stretched uniformly and broken one by one. There is some deformation at the tear locus, due chiefly to the force exerted at this site by the ends of the torn fabric which are still gripped in the jaws. This is more likely to occur with fairly heavy fabrics than with the lightweight materials used in the experimental part of this paper. The analyses of this test cited above (*3, 9*) indicate that it should behave to a large extent as if it were strongly dependent on simple tensile properties and relatively insensitive to fabric distortion factors.

On the other hand, the Elmendorf tear tester directly grips none of the yarns that are broken in the tear. The force is transmitted to the tear site by the transverse yarns in the tails of the test pieces which are clamped in the tester jaws. This arrangement permits a maximum amount of yarn movement and fabric distortion. However, this test measures the work required to tear a sample of a given length in two. In this length, there are only a certain number of yarns to be broken, and it should make little difference in the work whether or not they are broken singly or in groups in the distorted fabric. As the pendulum swings and the jaws separate, the yarns transverse to the direction of the tear are broken and the work consumed is measured by the retardation of the pendulum. If the fabric is geometrically stabilized, for example by heavy starching or by plastic coating, there is no other contribution to the total work of tear. If distortion can occur in the fabric, the force of the jaws is transmitted to a larger area of the fabric where yarns can be moved, uncrimped and stretched, which consumes further work. It is therefore to be expected that the Elmendorf test will be somewhat more sensitive to factors affecting fabric distortion than the trapezoid test.

The mechanism of the tongue tear test is essentially the same as that of the Elmendorf test. From the Instron record it is possible to determine the work of tearing, which should be comparable to the Elmendorf value. However, in the present study the Instron record has been evaluated in another way. A representative value for the maximum load during the tear was determined, and for convenience this was taken as

TABLE I

Effect of quaternaries of different chain length on the properties of cellulose fabrics

Experiment 1

Property	Chain length	Quarternary concentration 0%	0.5%	1%	2%	5%
A. COTTON						
breaking load (lbs/½ in)	C_6	26.9	25.2	23.5	24.5	22.6
	C_{12}	25.1	25.8	22.7	23.5	22.7
	C_{18}	26.1	23.8	23.7	22.7	23.1
breaking extension (%)	C_6	11.8	11.7	11.6	11.3	11.1
	C_{12}	11.8	12.0	12.2	10.5	12.8
	C_{18}	13.7	13.2	11.1	12.3	10.8
Elmendorf tear (scale reading)	C_6	47.7	44.4	41.7	35.7	39.3
	C_{12}	44.0	40.7	46.0	44.5	43.8
	C_{18}	48.3	52.3	56.3	60.0	61.3
tongue tear (lbs)	C_6	1.66	1.68	1.63	1.60	1.47
	C_{12}	1.72	1.60	1.51	2.01	1.50
	C_{18}	1.70	2.81	2.97	3.16	3.72
trap tear (lbs)	C_6	2.87	3.18	2.81	2.69	3.28
	C_{12}	3.05	2.77	2.67	2.61	2.73
	C_{18}	2.68	3.78	3.27	3.44	3.32
B. RAYON						
breaking load (lbs/½ in)	C_6	24.5	26.5	24.8	26.8	25.4
	C_{12}	24.2	26.2	26.8	25.7	26.7
	C_{18}	29.9	31.1	32.9	29.1	30.3
Elmendorf tear (scale reading)	C_6	105.3	92.0	103.3	98.0	99.3
	C_{12}	105.7	108.0	97.7	109.3	99.3
	C_{18}	98.7	114.0	114.4	127.3	112.0
tongue tear (lbs)	C_6	2.75	2.30	2.75	3.47	2.65
	C_{12}	2.89	3.46	3.14	3.92	3.29
	C_{18}	2.66	3.53	4.34	4.26	4.65
trap tear (lbs)	C_6	9.36	8.92	9.06	9.65	8.89
	C_{12}	9.60	9.86	9.71	9.60	8.96
	C_{18}	10.22	9.38	12.28	10.06	10.22

TABLE II

Effect of Triton K-60 and methylol ureas on phsical properties of cotton

Experiment 2

Property	K-60 conc	Monomethylol urea conc 0%	3%	6%	12%	Dimethylol urea conc 0%	3%	6%	12%
breaking load (lbs/½ in)	0	25.3	22.1	20.8	20.0	24.4	20.4	16.8	13.6
	.25%	23.2	20.7	20.9	19.5	24.7	19.0	15.7	12.8
	.50%	22.6	21.7	18.7	18.8	23.2	18.4	15.6	11.8
	1.0%	23.0	20.1	18.4	17.9	20.5	17.4	14.2	10.4
breaking extension (%)	0	12.1	10.4	11.4	8.9	12.7	10.5	9.4	7.4
	.25%	12.4	10.7	10.8	9.6	10.4	9.6	7.8	8.3
	.50%	12.8	11.7	9.4	8.7	11.0	8.2	7.4	7.7
	1.0%	12.1	12.2	13.3	11.3	12.8	9.6	8.9	8.6
trap tear strength (lbs)	0	3.57	3.14	2.79	1.96	2.81	2.61	1.92	1.26
	.25%	4.13	2.71	3.13	1.99	3.81	2.77	1.59	1.67
	.50%	3.99	2.92	2.75	2.30	3.17	2.25	2.05	1.41
	1.0%	3.38	3.09	2.30	2.40	3.74	2.10	1.67	1.40
Elmendorf tear (scale reading)	0	52.7	42.3	40.7	41.0	50.0	40.0	29.3	30.0
	.25%	69.0	54.0	56.0	48.0	61.7	48.3	42.0	35.7
	.50%	72.0	62.0	52.0	53.3	67.3	49.0	48.0	31.3
	1.0%	69.7	63.0	58.7	53.0	65.7	47.6	39.0	34.7
tongue tear strength (lbs)	0	1.77	1.58	1.38	1.20	1.54	1.21	1.01	0.76
	.25%	2.82	2.62	2.12	2.05	2.98	1.57	1.06	0.85
	.50%	3.08	2.43	2.47	1.60	3.30	1.96	1.87	0.75
	1.0%	3.11	2.54	2.49	1.96	3.24	2.04	1.24	0.97

TABLE III

Effect of Triton K-60 and methylol ureas on physical properties of rayon

Experiment 2

Property	K-60 conc	Monomethylol urea conc 0%	3%	6%	12%	Dimethylol urea conc 0%	3%	6%	12%
breaking load (lbs ½ in)	0	23.5	24.9	26.6	29.0	23.8	23.5	25.1	24.0
	.25%	23.3	24.8	26.1	28.6	26.7	27.4	25.4	25.6
	.50%	24.8	25.0	25.8	26.2	26.6	26.5	27.0	25.0
	1.0%	23.9	23.9	27.8	21.0	26.6	29.1	29.7	27.5
breaking extension (%)	0	29.9	32.0	29.4	27.2	29.5	25.6	24.0	18.5
	.25%	27.6	30.6	34.1	26.0	32.4	26.4	25.1	23.8
	.50%	32.8	33.1	29.8	30.2	35.0	25.3	27.5	19.8
	1.0%	29.5	32.8	30.3	25.1	34.6	27.0	34.8	21.6
trap tear strength (lbs)	0	8.27	8.57	8.03	7.65	8.56	8.48	7.01	4.56
	.25%	9.44	8.36	9.02	7.80	10.08	8.80	7.32	5.70
	.50%	9.56	11.30	8.66	8.64	9.96	8.82	6.44	6.00
	1.0%	9.10	8.96	8.70	8.16	9.26	8.30	6.66	5.11
Elmendorf tear scale reading)	0	100.0	103.3	106.0	102.0	106.0	94.7	95.3	71.0
	.25%	123.3	108.7	118.0	100.7	117.3	101.7	98.0	76.7
	.50%	102.7	122.0	113.3	109.3	115.3	104.0	95.3	89.3
	1.0%	124.7	120.0	122.7	98.0	121.3	118.0	97.3	88.1
tongue tear strength (lbs)	0	2.49	2.12	2.00	1.84	2.44	2.32	1.54	1.49
	.25%	3.84	3.30	3.31	3.16	3.88	3.15	2.94	2.12
	.50%	3.63	3.46	3.31	2.70	3.46	3.32	2.82	2.22
	1.0%	3.60	3.48	3.44	2.99	3.85	3.08	3.09	2.06

the median maximum load. The Instron record is a saw-toothed line, and without an integrator the simplest way to evaluate such a record is to determine the median peak of a suitable length of the saw-toothed curve. The result obtained in this way will be even more sensitive to the effect of distortion on tear than the Elmendorf test, since it will be more representative of the number of yarns being stressed at a given time during the tearing process. Maximum load is probably also a good choice as a measure of practical utility, for in many end-use tears the maximum load may limit the tear by stopping the jaw separation or by causing jaw failure, such as when the snag causing a tear is deformed sufficiently to release the fabric.

SUMMARY———It can be said that tear resistance appears to depend strongly on at least two fabric properties, tensile strength and deformability, and that the three common tear tests are different in their relative sensitivity to these factors. This means that when the effect of a finishing agent on tear strength is evaluated, the result may be strongly influenced by the test used. The effect observed will also be determined by the relative effect of the finishing agent on the fabric's tensile strength and deformability. The experiments described in the following section provide illustrations of the effects of materials representative of three classes of finishing agents, softeners, internal resins and surface resins. In the subsequent discussion the data are interpreted in terms of the factors described above.

EXPERIMENTAL

Three experiments were done to provide data for illustrating and amplifying the above comparison of tear test methods. In the first, three quaternary ammonium compounds having alkyl groups of different chain length were compared in their effects on the tear strength and other physical properties of cotton or rayon fabric. The second experiment was a study of the tear strength of cotton and rayon fabrics treated with combinations of a quaternary softener and a urea-formaldehyde precondensate. The third experiment compares the effects on tear strength of soft and hard resins applied to the fabric as prepolymerized dispersions.

EXPERIMENT 1———Hexyl-, dodecyl- and octadecyldimethylbenzyl ammonium bromides were applied to cotton and rayon fabrics from aqueous solutions containing 0, 0.5, 1, 2 and 5% solids. The applications were done with 2 dips and 2 nips on a heavy laboratory padder, which gave a wet pickup of 80% on the cotton and 100% on the rayon. The wet samples were framed at their original dimensions and dried at 125°C. The cotton fabric was an 80 x 80 4-ounce printcloth. The rayon was an 80 x 64 challis weighing 3.4 ounces per yard. The dodecyl- and octadecyldimethylbenzyl ammonium bromides were commercial materials from Fairfield Laboratories. The hexyl derivative was prepared by quaternizing dimethylbenzyl amine with hexyl bromide.

EXPERIMENT 2———The same cotton and rayon fabrics were treated with monomethylol and dimethylol ureas in combinations with Triton K-60, a commercial quaternary ammonium softener. Application levels of 0, 3, 6 and 12% solids were used for the resin precondensate with 0, 0.25, 0.50, 1.0 and 2.0% solids of Triton K-60. Ammonium chloride was used to catalyze the resin at a concentration of 0.2 millimole/gram of precondensate. The applications were made as in the first experiment and the dry, framed samples were cured for 10 minutes at 150°C. The cured samples were not afterwashed.

EXPERIMENT 3———Samples of both fabrics were treated with various levels of two synthetic polymer latices, Rhoplex S-1 and Rhoplex WN-77. The first of these forms very soft, extensible films on drying, while the second is much harder and stiffer. Aqueous dilutions of these materials were applied on the laboratory pad, framed at their original dimensions and dried at 125°C. The concentrations of resin solids used were 0, 0.5, 1.0, 1.5, 2.0, 3.0, 4.0 and 5.0%.

TESTING———The samples were tested after they had equilibrated to standard atmospheric conditions, using the following test procedures:

1) *Tear strength*

a) Tongue test—Two 4 x 4 inch samples were prepared with a 1-inch cut in the center of one edge. The

TABLE IV

Effect of two surface resins on the strength of cotton and rayon fabrics

Experiment 3

Resin treatment	Tensile strength (lbs/inch) rayon	cotton	Tongue tear (lbs) rayon	cotton	Trapezoid tear (lbs) rayon	cotton
control	44.1	46.2	1.87	1.09	8.23	2.55
0.5% S-1	45.0	43.7	1.82	1.12	7.72	2.66
1.0% "	44.9	44.9	2.00	1.13	7.59	2.48
1.5% "	45.1	43.4	1.96	1.24	7.66	2.74
2.0% "	42.8	44.2	1.90	1.20	7.32	2.69
3.0% "	45.6	43.8	2.49	1.45	8.13	2.72
4.0% "	43.2	42.6	2.12	1.21	8.08	2.67
5.0% "	43.0	41.5	2.36	1.32	7.38	2.58
0.5% WN-77	43.1	46.5	1.45	1.08	7.50	2.64
1.0% "	42.0	48.4	1.29	1.08	6.94	2.89
1.5% "	43.9	45.7	1.29	0.99	7.33	2.78
2.0% "	43.1	44.9	1.24	1.03	6.99	2.83
3.0% "	42.5	47.6	1.25	1.03	6.74	2.53
4.0% "	41.9	49.1	1.16	1.05	6.56	2.78
5.0% "	41.0	46.8	1.05	0.97	6.18	2.70

two tails thus formed were inserted to a depth of 0.75 inch in the jaws of the Instron tester, and the sample was torn by the single-rip procedure. The median maximum load in the first inch of tear was determined from the chart record. These test pieces are smaller than those specified by the ASTM standard (*1*).

b) Elmendorf test—Three samples were tested with a tester as described in the ASTM standard (*2*). The tear length was 1.63 inches and the results are reported simply as scale readings.

c) Trapezoid test—Two samples were tested by the ASTM procedure (*1*) using the Scott IP-4 tester.

2) *Tensile properties*

Two strip samples ¾ x 5 inches were cut and frayed to exactly ½ inch width. They were extended on the Instron tester from a guage length of 2 inches at a rate of 25% per minute until they broke. Breaking load and elongation were determined from the chart record.

All tests were done only on warp-direction samples. In statistical evaluation of the data, the 1% significance level has been used for F tests in analyses of variance. The confidence limits shown in Figure 3 are ± twice the standard deviation of the plotted value.

The test data are given in Tables I, II, III and IV.

DISCUSSION

Quaternary ammonium compounds have been used for many years to soften the hand and improve the tear strength of fabrics. It is believed that they produce these effects by lubricating the surface of the fibers, and it is to be expected that they will be effective only when one of the substituents becomes large enough to give a waxy or greasy nature to the compound. This will also increase the surface activity of the material and make it more difficult for it to penetrate the fiber. Both of these effects will lead to its concentration at the fiber surface where it can act as a lubricant. These ideas are relatively old in this field and lead one to expect that the effect on tear strength of the three compounds in the first experiment will increase with the length of the alkyl chain. The oberved effect is shown in Figure 1, where the average relative tear resistance for the three tests are plotted against the chain length of the quaternary. Analysis of variance on the original data showed that there are no significant differences with chain length for the trapezoid data, and that there is no justification in these data for drawing anything but a straight line

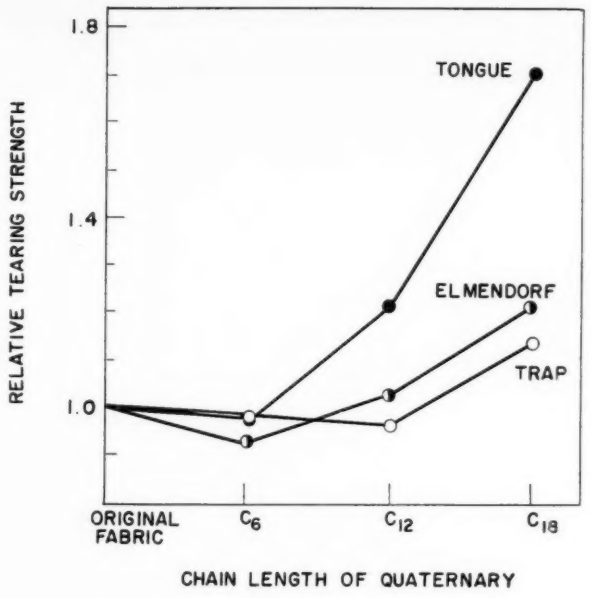

Figure 1
Effect of chain length on the tear strength change produced by alkyl dimethylbenzyl ammonium bromides

through the four points. However, both the Elmendorf and the tongue tests do detect differences due to quaternary compositions, and the tongue test gives the largest change in level.

A more detailed comparison is made in Figure 2 which shows the concentration dependence of the effect of the three alkyl dimethyl benzyl ammonium bromides on the tear strength of cotton printcloth as measured by the three tear tests. The data for the trapezoid test show no differences among the three quaternaries. Both the Elmendorf and tongue tests show very distinctly that the C_{18} compound is effective in improving tear strength while the other two materials are relatively ineffective. The data for rayon challis are qualitatively similar, but show more scatter of individual points.

Data for both cotton and rayon are given in Figure 3, which shows the effect of Triton K-60 on tear strength. The data have been averaged over resin concentration levels since an analysis of variance showed no interaction between the resin and softener effects. On both fabrics the trapezoid test again shows no difference in tear strength produced by the finishing agent, while the Elmendorf and tongue tests show a very considerable increase in the tear resistance.

Quaternaries of this type seem to have little or no effect on the breaking elongation of either fabric. However, they reduce the tensile strength of cotton about 10%. This decrease in strength as a result of adding a lubricant is in line with the observation that solvent removal of natural waxes and other lubricants increases the strength of cotton fabric (*12*). However the effect may not be as simple as this implies since it appears that the C_6 and C_{12} compounds do not differ in this respect from the C_{18} material. Nevertheless, in Figure 2 the C_6 and C_{12} compounds appear to have reduced the tear strength values a little as would be expected from the tensile strength changes even though the differences are not statistically significant. In the tensile behavior of rayon there turned out to be an interaction in the data of Experiment 1 between the composition and concentration effects. The meaning of this could not be resolved by plotting the data separately, but it would appear that if there is a real concentration effect it is small and positive. There was no significant effect of Triton K-60 on the strength of rayon in the second experiment. The behavior is definitely not like that of cotton and is probably due to differences in the nature of the surfaces of these two fibers.

Creaseproofing resins, such as urea - formaldehyde, melamine - formaldehyde, and ethylene urea-formaldehyde precondensates, reduce the breaking strength and extension of cotton fabrics. They reduce the extension of rayon fabrics also but may change breaking strength in either direction. These changes normally result in a reduction in tear strength no matter which test method is used. In Figure 4 relative tear

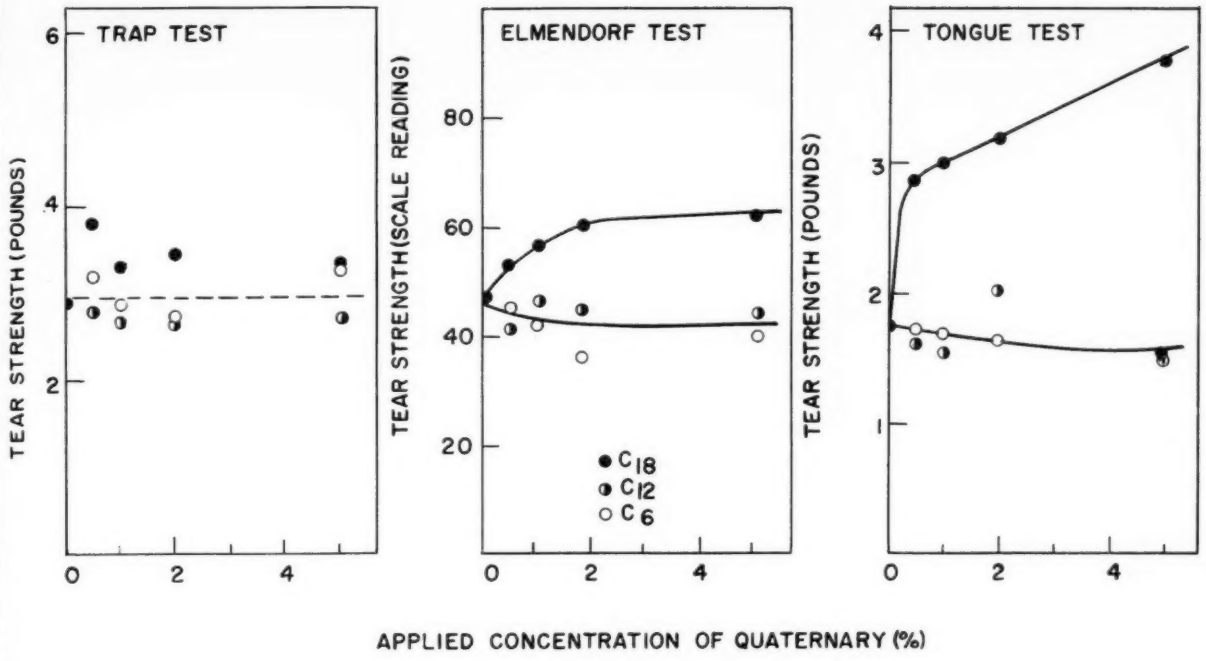

Figure 2

Effect of concentration on the tear strength change produced o n cotton printcloth by alkyl dimethylbenzyl ammonium bromides

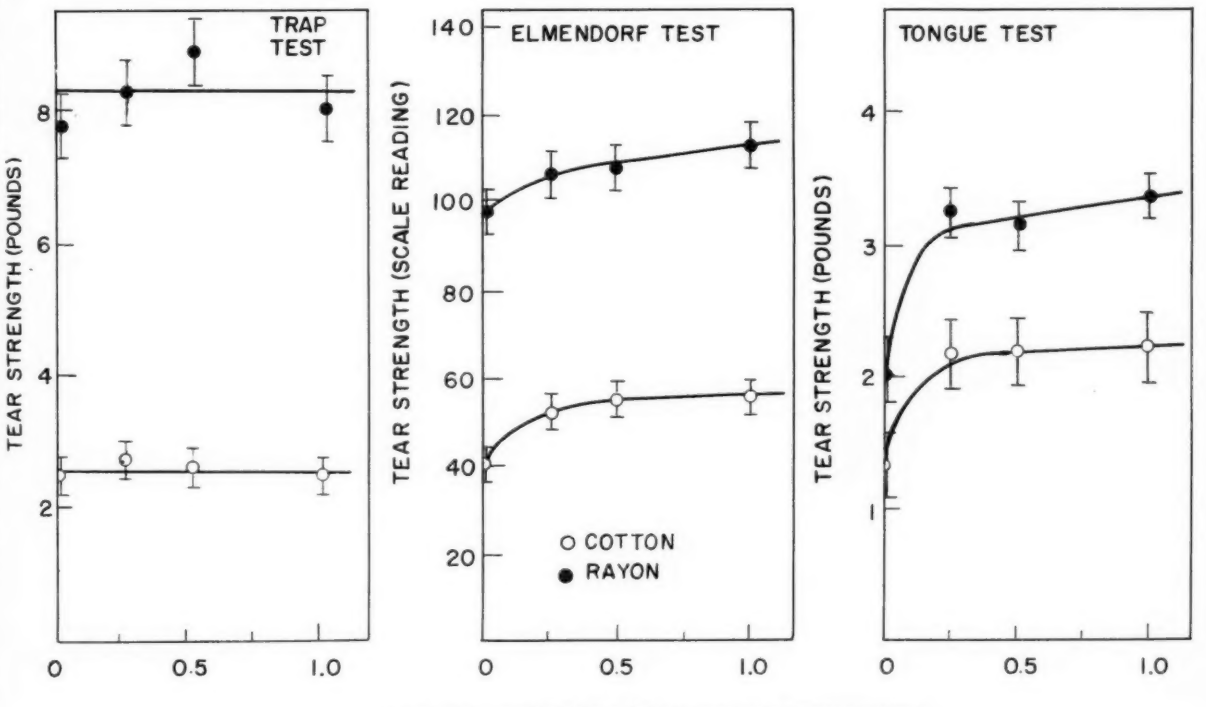

Figure 3

Effect of Triton K-60 on tear strength

strength of the samples from Experiment 2 is plotted against their toughness index (7), which is a simple function of breaking strength and elongation:

$$\text{toughness index} = \frac{\text{breaking strength} \times \text{elongation}}{2}$$

The results of the three different tests fall closely together, which indicates that the loss of tensile toughness is the primary, perhaps the only, cause of tear strength loss in these treatments. The resin treatment very

probably does not produce any significant change in the fabric deformation factor. This conclusion strongly implies that the contributions of tensile strength and the fabric deformability factor are independent in their effect on tear strength.

Aminoplast resins such as those discussed in the preceding paragraph are deposited within the fiber structure and change the properties of the individual fibers rather than changing the number or kind of interactions between the fibers in the fiber assembly. On the other hand, there are numerous types of pre-polymerized resins which are applied to textile fabrics to alter their properties, particularly their handle and stiffness. Typical of these materials are synthetic latices, such as the Rhoplexes used in Experiment 3. Resins of this sort cannot penetrate the fiber and must remain upon the surface, bonding the fibers together and changing the properties of the fabric to a degree dependent upon the properties of the resin itself. Very hard, tough resins of this sort bind the fibers and yarns together, reduce the deformability of the fabric, and by the mechanism discussed in the early part of this paper, decrease the tear strength of the fabric when it is measured by a test which emphasizes this factor. Common examples of this sort of behavior are found in shade cloth, tag cloth and other light-weight coated fabrics. On the other hand, soft, extensible materials will actually improve the tear strength of fabric (*8*). The data in Figure 5 from Experiment 3 show the effects of hard and soft surface resins on tear strength as determined by the tongue and trapezoid methods. The tear strength relative to the untreated fabric is plotted against the concentration of applied resin. The results for the cotton and rayon fabrics have been averaged.

With the tongue test Rhoplex S-1 increases tear strength, while WN-77 decreases it. With the trapezoid procedure the change in tear strength is not significant with either resin. Neither resin affects the tensile strength of rayon. The harder resin also has no effect on cotton, but the softer causes a slight loss in strength. Although it seems unlikely that a soft, tacky resin can act as a fiber lubricant in the same way that quaternary ammonium compounds do, the most probable mechanism for the effect of this resin on tear strength seems to be one of lubrication which is effective only at high deformations where inter-fiber and inter-yarn resin bridges have been broken (*8*).

Since both the Elmendorf and tongue tests appear to be sensitive to the fabric deformation factor in tear resistance, it would be of interest to compare these tests a little further, especially since the Elmendorf test can be done in much less time than a tongue test. In Figure 6 Elmendorf tear value is plotted against tongue tear strength for all of the cotton and rayon samples from Experiment 2. The Elmendorf tear value is the work done in tearing a given length of fabric, that is,

Elmendorf tear value = work of tear = av tear load x length of tear x 2.

The tongue tear strength as measured above is simply the average maximum load during tearing,

tongue tear = maximum load.

Dividing the first of these relationships by the second, we obtain

$$\text{Elmendorf tear} = \text{tongue tear} \times \frac{\text{average load}}{\text{maximum load}} \times \text{length} \times K,$$

where

K includes any constants necessary to rationalize any differences in units. The curvature of the lines in the figure, which is apparent even though the rayon data are badly scattered, would mean that the ratio of the average tearing load to the maximum tearing load is not constant, as this *a priori* relationship implies. The fact that the rayon and cotton data

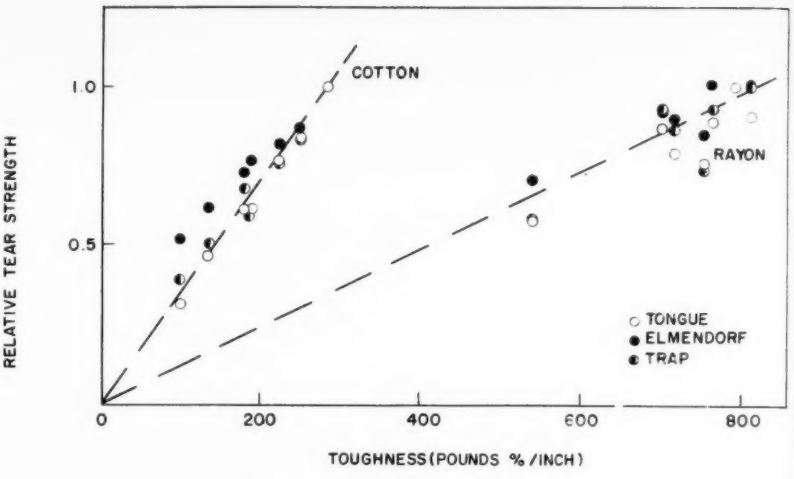

Figure 4
Relation of tear strength to toughness index

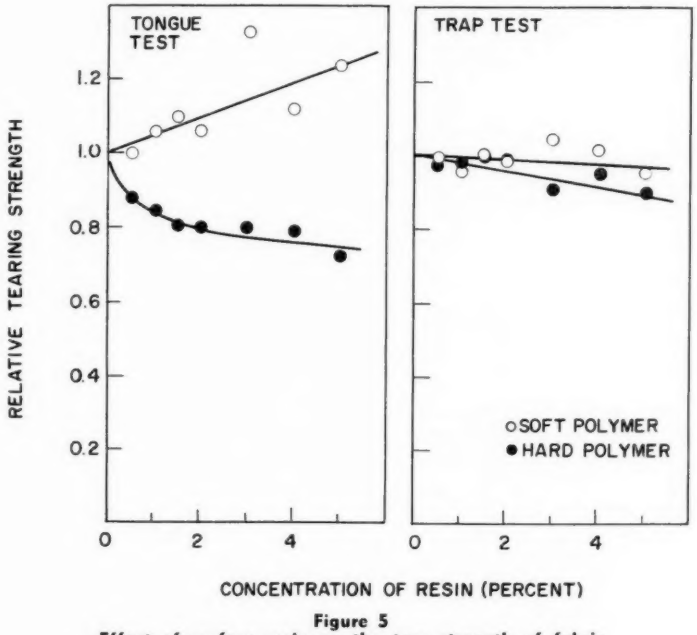

Figure 5
Effect of surface resin on the tear strength of fabric

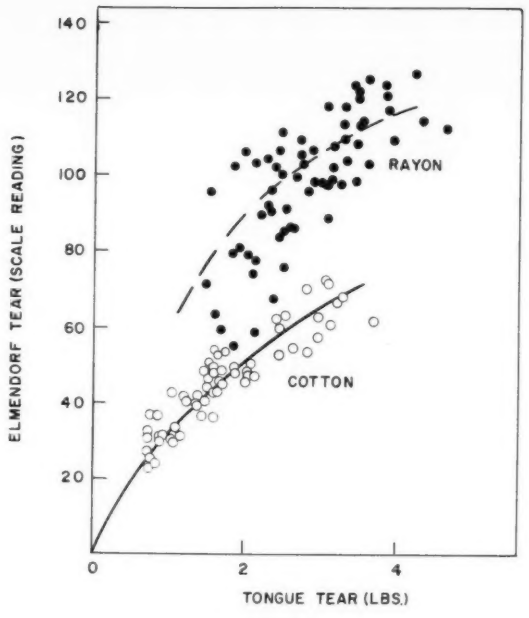

Figure 6
Relationship between tearing strength determined by the Elmendorf and tongue tests

do not fall on the same line further indicates that there is a rather large difference in the value of the ratio for the two fabrics. Estimated from the graph, the ratio for rayon between the average load and the maximun load seems to be about one and a half times the ratio for cotton. The difference in the tearing behavior of the two fabrics was checked further by determining the average load from Instron charts of the tongue-tear test by planimetering the area under the tearing load record. When this was plotted against the average maximum load from the same tests, a single straight line for both the rayon and cotton points was obtained, so that the difference in the figure between the two fabrics must be due to some difference between the tongue and Elmendorf tests, very possibly the difference in their rates.

The Elmendorf test is carried out at a much higher rate of tear than the tongue-test. The important difference may also be that the Elmendorf rate is not constant and that the average rate depends on the strength and elongation of the sample. Since the elongation in particular is very different for cotton and rayon, this could perhaps account for the difference between these two fabrics in Figure 6. The Elmendorf test is carried out about 500 times faster than the tongue-tear test.

CONCLUSIONS

Consideration of the procedures used in the tongue, Elmendorf, and trapezoid tear tests and the results which various finishing agents have on tear strength lead to certain conclusions which make the significance of these tests somewhat clearer and throw some light on the effects of finishes on this sort of fabric behavior. Tear resistance depends primarily on two factors—tensile behavior and fabric deformability—which appear to act independently. The tongue-tear test is relatively sensitive to the deformability factor in tear resistance, the Elmendorf test is somewhat less so, and the trapezoid test is relatively insensitive. These tests are equally sensitive to tensile behavior. Quaternary ammonium compounds which can act as fiber lubricants increase fabric deformability, but have only minor effects on tensile properties. Urea-formaldehyde resins affect tear resistance simply as a result of changes in tensile strength and elongation of the component fibers. Surface resins affect tear resistance by the changes they produce in fiber-to fiber interactions in the fiber assembly.

ACKNOWLEDGMENT

The experimental work described in this paper was very ably carried out by Mrs Angela Simonson.

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General Calendar

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Gordon Research Conference on Textiles, July 8-12, Colby Jr College, New London, NH

AMERICAN OIL CHEMISTS SOCIETY
Sept 30-Oct 2, 1957 (Fall meeting, Cincinnati); Apr 21-23, 1958 (Memphis); Oct 20-22, 1958 (Chicago); Spring, 1959 (New Orleans); Fall, 1959 (Los Angeles).

AMERICAN SOCIETY FOR QUALITY CONTROL—TEXTILE DIVISION
8th Annual Conference—Jan 30-Feb 1, Clemson House, Clemson, SC

THE DRYSALTERS CLUB OF NEW ENGLAND
June 21 (Annual Outing—Wachusett Country Club, West Boylston, Mass).

THE FIBER SOCIETY
Sept 4-6 (Joint meeting with the Textile Institute—Hotel Statler, Boston, Mass)

NATIONAL COTTON COUNCIL OF AMERICA
October 2-3 (Chemical Finishing Conference—Statler Hotel, Washington, DC)

PHILADELPHIA TEXTILE INSTITUTE ALUMNI ASSOCIATION
June 6-8 (Alumni Day, Alumni Outing, PTI Commencement)

PURDUE UNIVERSITY
May 13-15 (12th Purdue Industrial Waste Conference, Purdue Univ, Lafayette, Ind)

SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION OF THE UNITED STATES
May 26-28 (Annual Outing Skytop, Pa); June 11, Sept 10, Oct 8, Nov 12 (Palm Terrace Suite, Hotel Roosevelt, New York, NY)

• PATENT DIGEST •

PAUL WENGRAF

UNION DYEING OF WOOL-CELLULOSE ACETATE MIXTURES———Nonionic and Anionic Agents Added C,4,07

USPat 2,760,841 (Celanese Corp of Am——Salvin, Studer——Aug 24, 1956)

When dyestuffs for wool and dyestuffs for acetate were incorporated in the same dyebath for the purpose of dyeing mixed fabrics of wool and cellulose acetate, the dyeings were found to show poor lightfastness and insufficient resistance to crocking. It has been observed that these unsatisfactory results are caused mainly by staining of the wool portion by the dyestuffs for acetate in the dyeing process. Since a two-bath method is relatively expensive, the application of both dyestuff classes from a common bath would be most desirable.

The problem reportedly has been solved by dyeing these mixtures in a bath containing *selected* anionic and nonionic agents. Tamol N and Lomar PW (sulfonated naphthalene formaldehyde condensates) are advocated as anionics, and Quakester 236 (polyethoxylated fatty acids) or Elvanol (polyvinylalcohol) as nonionic assistants. Appropriate dyes for wool, eg, Anthraquinone Blue SKY (Du Pont, *CI* 1088), and dyes for acetate of the amino anthraquinone group are combined in the dyebath, which contains 0.5-2.0 g/l of each of the abovementioned dispersing agents. Little or no tendency to stain the wool portion is observed. A slight stain, which may appear after dyeing, can be removed by an aftertreatment with soap and the same anionic agent used before in the dyeing.

Example: A fabric containing a 50/50 blend of cellulose acetate and wool was dyed for one hour at 80° C with Anthraquinone Blue SKY and a mixture of amino anthraquinone dyes; 0.5 g/l Tamol N and 0.5 g/l Quakester 236, some ammonium acetate and Glauber's salt were added. The dyed fabric was aftertreated at 35-40° C in a bath containing soap and Tamol. A uniform blue shade, fast to light and crocking, resulted.

The method can be applied as well to mixtures of wool and Dacron.

Among the references cited by the Patent Office:

Ger Pat 646,001 (Geigy/1937) covers a one-bath dyeing method for cellulose acetate and wool mixtures with the dyes for acetate and for wool combined. High alkylsulfates are added as assistants.

USPat 1,534,019 (Brit Dyestuffs Corp/1925): a sulfonated naphthalene-formaldehyde condensate is used to render insoluble acetate dyes more dispersible.

USPat 2,310,074 (Unichem/1943) covers a means for preventing adsorption of anion-active surfactants on wool in acid-dyeing operations by the addition of nonionic agents, such as polyethoxylated alkyl phenols or fatty acids.

PIGMENT PRINTING COMPOSITION Containing Cellulose Ester Mixture D,2,07

USPat 2,761,789 (Sandoz A G——Locher, Duerst——Sept 4, 1956)

The inventors refer to the well-known Serikose printing process (see below), which calls for the application of cellulose ester solutions as carriers, and, at the same time, fixing agents for various pigments.

The present modification of the standard Serikose process consists of kneading any pigment (organic dye or inorganic compound or metal) with acetylcellulose, preferably of an acetic acid content of 45-60% bw in the presence of a solvent. The solvent may be a "true" solvent, such as acetone, cyclohexanone, diacetone alcohol, etc, or a "semisolvent," ie, a combination of compounds that are nonsolvents individually but have a solvent effect when blended together, eg, ethanol plus benzene. Solid, water-soluble inorganic salts may be added to reduce the particle size of the pigment during kneading. A pulp is formed, which is essentially a pigmented carrier. It is processed further as in the Serikose process. Stronger and brighter printing effects reportedly result.

Example: Acetylcellulose was swollen with acetone and the mixture kneaded with a green pigment (hexadeca chloro copper phthalocyanine). Water was further added during kneading until the cellulose acetate precipitated, forming with the pigment a coarse pulp, which was repeatedly washed, dried and stirred with a paste of acetylcellulose, and dissolved in a mixture of acetone, benzylalcohol and ethanol. A bright print, fast to light, was obtained.

An improvement of the Serikose process reportedly has been obtained by Kielbasinski and Jacubowski according to *Melliand II*, 132 (March, 1921) by pasting the metal powder with Serikose, dissolved in aniline, nitrobenzene or preferably xylidine.

Abstracts———

(Concluded from page 316)

bers has been studied. The fibers used included normal acetate (with the usual serrated cross-section), circular cross-sectional acetate, nylon, Terylene, and viscose rayon. Filament deniers varied from approximately 2 to 16. Soil content was determined by dissolving the soiled fiber in a suitable solvent and measuring the optical density of the resulting suspension.

In general, soil retention increases with decreasing filament denier, and for any one type of fiber, eg, acetate, circular cross-sectional fibers retain less soil than those of similar denier but having a serrated cross-section. Soil retention by any one type of fiber is a linear function of the gross surface area of the filaments. There are differences in soil retention by various chemical types of fiber that apparently cannot be related to differences in physical size and shape of the filaments. The influence of static electricity on soiling is not clear, soil retention showing no correlation with the magnitude of the electrostatic charge. The visual appearance of soiled fibers is not necessarily indicative of the quantity of soil retained.

Twelve references to the literature are cited.—WHC

OBITUARY

CLIFFORD JONES

Clifford Jones, Mid-West representative for Scholler Bros, died April 7, 1957 following a long illness. He was 53.

Mr Jones began his career in the textile industry in 1925 with National Aniline & Chemical Co in Buffalo, NY. He was later transferred to Toronto, Ont, where he spent about four years. In 1933 he went to the Mid-West as a representative for John Campbell & Co. In 1936 he joined American Aniline Products, Inc in Chicago, where he served until joining Scholler Bros.

News of the Trade

Borden's Opens 2nd Southern Formaldehyde and Resins Plant

The Borden Co opened its second southern formaldehyde and resins plant on April 18th at Fayetteville, NC, with appropriate dedication ceremonies.

Geared to produce 36,000,000 pounds of formaldehyde annually, the plant was formally activated by A R Marusi, president of the Borden Company's Chemical Division, at open-house ceremonies attended by company executives and civic and industrial leaders from the southern area.

The Fayetteville plant is fully automated, and employs 25 workers. Its manufacture of formaldehyde is designed for a wide market. From the formaldehyde the plant will also make resins for sizing and finishing textiles. The plant also serves as a warehouse for polyvinyl acetate and polyvinyl alcohol.

The plant, a steel and concrete structure, is located on the banks of Cape Fear River. It is Borden's fifth formaldehyde producer in the US, the other plants being at Demopolis, Ala, Bainbridge, NY, Kent, Wash, and Springfield, Ore.

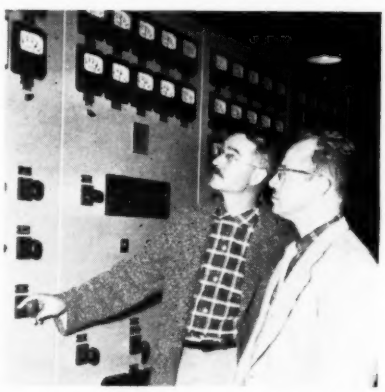
The local plant has special significance to the Borden Company, according to Mr Marusi. It is the first plant to be completed in the South during the Centennial year which the Company is now observing, he pointed out. It also marks an important step in the Company's progress and development in the chemical field, boosting the company's aggregate formaldehyde production to 12 percent of total domestic consumption, he said.

At present, methanol for the production of formaldehyde is being shipped to Fayetteville by rail, but future plans call for barge shipments via the Cape Fear River. A 420,000-gallon storage tank handles current shipments.

Ivan Welborn, superintendent of the Fayetteville operation, was introduced to guests by Eugene J Sullivan, vice president—sales, Chemical Division. The group was also addressed by Charles Fulp, Southern District manager.

Dedication of the Fayetteville operation shortly followed the announcement that Borden's Chemical Div has acquired The Lawrence Process Co, Inc, of North Andover, Mass, manufacturers and processors of extruded plastic products. It will operate as a wholly owned subsidiary.

DOUBLED: This newly enlarged plant of Olin Mathieson Chemical Corporation at McIntosh, Ala, can turn out twice its previous production of chlorine and caustic soda. An $8,000,000 addition has boosted the plant's capacity to 250 tons of chlorine and 280 tons of caustic soda per day. The expansion includes barge loading facilities on the Tombigbee River, which extend the plant's effective marketing area to points on the Gulf Coast, eastern seaboard, and inland waterways. The new portion of the plant is the light-roofed building at the right.



CHLORINE PLANT ON STREAM: Joseph L Wood, plant manager, is shown as he throws the master switch that starts up $8,000,000 addition to Olin Mathieson Chemical Corporation's chlorine and caustic soda plant at McIntosh, Alabama. Ralph Staker, assistant plant manager, looks on.

Dupont, GDC Join Felisol Assoc

By a recent vote of the General Assembly of the International Association for the Felisol Fastness Label, E I du Pont de Nemours & Co, Inc and General Dyestuff Co were admitted as members of the Association.

American dyestuff manufacturers interested in joining the Association may obtain information by writing to the International Association for the Felisol Fastness Label, Zurich 39, Switzerland.

New Heyden Newport Plant to Produce Salicylaldehyde

Heyden Newport Chemical Corporation is constructing a new plant at Fords, NJ, to produce over a million pounds annually of salicylaldehyde, an important intermediate in the manufacture of dyestuffs. It is reported that an entirely new catalytic process, developed by Heyden research, will be used which is economical and avoids the usual by-product problems.

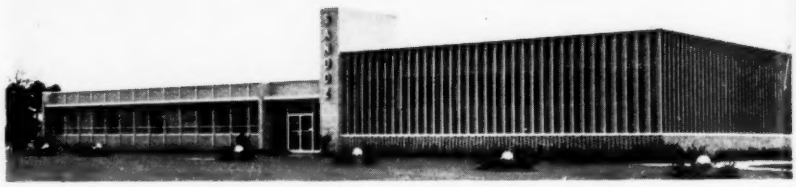
Heyden Newport is one of the leading producers of salicylic acid, salicylates, benzaldehydes and other aromatic intermediates. Salicylaldehyde is a logical addition to Heyden Newport's present product line.

Completion of the new plant is scheduled for early in the first quarter of 1958. Provisions are being made for future expansion.

New Sandoz District Office in Charlotte Scene of Spring Sales Meetings

District sales managers and other executives of Sandoz, Inc, Dyestuff and Chemical Divisions, viewed the company's new Charlotte office and laboratory Thursday, April 11, and Friday, April 12. The occasion was the annual regional sales meeting for the Charlotte and Cincinnati staffs, and the Spring 1957 district sales managers' meeting.

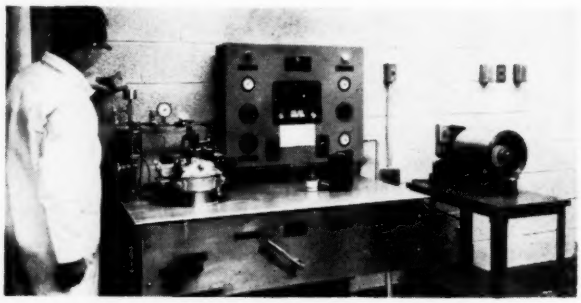
Located at 4000 Monroe Road, the new Charlotte buildings contain working areas for office operations, a complete dyestuff and chemical laboratory, and large storage and standardizing facilities. The laboratory contains machinery which duplicates, on a smaller scale, actual dyehouse production equipment. A portion of the lab contains "standard condition" rooms in which the temperature and humidity are maintained in a constant state.



Sandoz, Inc's new district office at Charlotte, NC

In this huge new warehouse of the Sandoz Charlotte office, palleting is used to store the company's stock of dyes and chemicals for the textile industry in the South. The mixing room contains a battery of dye mixers able to handle individual dye batches from 100 to 5000 lbs.

Interior of Sandoz' laboratory at Charlotte.



Laboratory model Gaston County package dyeing machine and extractor, installed in conditioned air, laboratory room at Sandoz' Charlotte laboratories.

Host to the Sandoz executives during their visit was Frank P Mackinney, manager of the Charlotte Office.

Corporate officers who spoke at the regional sales meeting included Dean W C Warren, chairman of the board of directors; J C Walker, vice president and manager of the Dyestuff Division; A T Hanes, vice president, sales and promotion, who was at one time manager of the Charlotte Office; and R A Lindenmaier, vice president of the Chemical Division. Other speakers were: T F O'Brien, manager of the Leather and Paper Departments; C H A Schmitt and H A Weil, director and associate director of the Sandoz Application Research and Development Laboratories; and W E Taylor and P F Haddock of the Charlotte District Office.

Technical subjects discussed at the regional sales meetings included the use of Sandoz dyes on the newer man-made fibers and application of the company's Lanasyn dyestuffs in the latest dyeing processes. Chemical Division representatives spoke on fixing agents, especially the new Sandofix WE Liquid; the increased use of fluorescent whiteners, such as the Leucophor series; and the use of wetting agents of the Resolin N type.

Sandoz district sales manager Frank Mackinney dictates a teletype message to one of the other offices of Sandoz, Inc.

Portions of the Regional Meeting program were held at the Charlotte City Club and Hotel Barringer. The district sales manager's meeting was held in the Charlotte offices. In addition to members of the Sandoz management already mentioned, the sales managers' meeting was attended by J W Thummel, treasurer; M E Gossweiler, M H Klein, R J Mitchell, and R A Schaefer.

Five Major Chemical Firms Licensed to Produce Syl-mer Silicone Finishes

Five leading chemical companies have been licensed to manufacture silicone emulsions for textiles and leather made with Syl-mer and Syl-flex water and stain-resistant finish by Dow Corning Corporation.

The new licensees are American Cyanamid Co, The Arkansas Company, Refined Products Co, Soluol Chemical Co and Warwick Chemical Division. Under terms of recent agreements concluded, the firms may use Dow Corning Sly-mer name and identifying trade mark in association with their own individual silicone emulsions. Each of their mill and finisher customers who are licensed to apply Syl-mer, can make Syl-mer tags available from Dow Corning to their manufacturer customers. Licensing arrangements also stress the maintenance of quality control standards. An expanded testing program for all Syl-mer-treated fabrics to assure proper end use performance is being effected.

AATCC EXHIBIT AT LTI OPEN HOUSE — The American Association of Textile Chemists and Colorists exhibit at the Open House program conducted last month by the Lowell Technological Institute featured a display of the effect of the Operation Cue atom bomb blast upon textiles. In the foreground, l to r, are Lt Col Harry E Stengele, commanding officer of the Air Force ROTC detachment at LTI; George O Linberg, president, AATCC; George Mandikos, technical manager, AATCC Research Laboratories; Glen Kidder, AATCC Research Laboratories; Richard R Frey, assistant secretary, AATCC; and Harold W Stiegler, director of research, AATCC.

Martin J Lydon, left, president of Lowell Technological Institute, chats with George O Linberg, center, president of AATCC and George P Paine, executive secretary, AATCC, in front of AATCC's exhibit at LTI's Open House program.

Sun Chemical Moving Headquarters to NYC

Plans to move all administrative and executive activities of Sun Chemical Corporation to New York City from Long Island City have been announced. President Norman E Alexander has stated that Sun Chemical has signed a lease to occupy approximately 42,000 square feet in a new 34-story building being erected at 750 Third Avenue, between 46th and 47th Streets. Plans call for occupancy early next year.

Sun Chemical administrative headquarters are now located at 10th Street and 44th Avenue in Long Island City. All personnel will be transferred to the new offices. However, no manufacturing or research activities will be affected by the move.

42nd Annual Meeting. Color Assoc of US

Samuel G Baker, general manager, Organic Chemicals Department, E I du Pont de Nemours and Company, Inc, was elected a director of The Color Association of the United States at its 42nd annual membership meeting, held April 11 at the offices of the organization, 200 Madison Avenue, New York.

The following directors were re-elected to the Association's board: John M Hughlett, vice-president, J P Stevens & Co, Inc, who is also president of The Color Association; Eleanor Lambert, president Eleanor Lambert, Inc; William G Lord, president, Galey & Lord and vice-president, Burlington Industries, Inc; W Ralph MacIntyre, president, Joseph Bancroft & Sons Co; Newton J Rice, president, Wear-Right Gloves, Inc; Armand Schwab, president, Armand Schwab & Co, Inc; Dorothy Shaver, president, Lord & Taylor, and vice-president, Associated Dry Goods Corp; Roy E Tilles, past president, The Color Association of US, Inc; Henry C Van Brederode, president, Earl Loom Fabrics, Inc; and John F Warner, vice-president, D B Fuller & Co, Inc.

At a luncheon meeting of the board held at the Empire State Club directly following the members' meeting, the present officers of the Association were re-elected to serve another year. In addition to Mr Hughlett as president, they are: Armand Schwab, 1st vice-president, John F Warner, 2nd vice-president, Estelle M Tennis, secretary, and Henry C Van Brederode, treasurer. Miss Tennis was also re-elected executive director.

In her annual report, reviewing the Association's activities for the fiscal year 1956, Miss Tennis said the new members enrolled during this period represent a constantly broadening cross-section of industry, indicating the growing impact of color in more and more fields. In addition to every important segment of fashion, it is significant, she added, that the Association's membership embraces an increasing number of firms in the home furnishings branches.

During 1956, the Association issued over 21,000 seasonal color cards, advance swatch sets and standard cards. There has been a considerable increase in the special color consultation service rendered members in addition to many facets of women's, men's and children's wear. Members, various branches of the government and trade groups make wide use of the Association's color information bureau.

58th LTI Alumni Reunion

Elaborate plans are being made for the 58th annual reunion of the Lowell Technological Institute Alumni association Saturday, May 18.

Following registration on campus, the morning session will be devoted to the annual business meeting with Bryan Leonard, treasurer of the East Weymouth Wool Scouring Company, presiding. The graduating class will be guests of the alumni at luncheon.

A sports program will be held in the afternoon at the Andover Country Club with a social hour at 6 o'clock. Dinner speaker will be Commissioner Richard Preston of the Massachusetts Department of Commerce and president of Economic Development Associates, Inc, Boston, Mass. He will discuss "Building for the Future in Massachusetts," an evaluation of the assets, liabilities, and forces working in the state.

Chairman of the reunion is Paul J Martin, Socony-Vacuum Oil Co, whose committee includes Joseph V Kopycinski, Dorrance H Goodwin, Clifford A Harvey, Glen M Kidder and George A Scagos.

Joint Textile College Alumni Meeting Attracts 250 in NY

The first joint meeting and banquet of textile college alumni in the New York area attracted a turnout of approximately 250 on March 21st at the Tavern-on-the-Green.

One of the avowed purposes of the meeting was to focus attention on the importance of textile education and the textile industry in planning careers for young people.

Guests at the meeting, which had as its theme, "Meet the President," included Robert T Stevens, president, and Joseph Sutherland, board vice chairman, J P Stevens & Co, Inc; Jacob W Schwab, president, United Merchants & Mfrs, Inc; Andrew Sokol, also of J P Stevens & Co, Inc, and president of the National Federation of Textiles; Jackson Spears, vice president, Burlington Industries, Inc; Walter Ross, president, Textile Distributors Institute; Marvin R Cross, president, Greenwood Mills. Inc; John E Reeves, president, Reeves Bros, Inc; Brackett Parsons, president, Pepperell Mfg Co; Ellis Leach, president, Collins & Aikman Corp; William E Reid, president, Riegel Textile Corp; and Frederic H Barth, president, Industrial Rubber Co.

The following administrative heads from various colleges offering textile programs also were present: Martin J Lydon, president, Lowell Technological Institute; Bertrand W Hayward, president, Philadelphia Textile Institute; John Foster, president, New Bedford Institute of Textiles and Technology; Hugh M Brown, dean, School of Textiles, Clemson College; and Benjamin Whittier, representing Dean Malcolm E Campbell of North Carolina State College School of Textiles.

Cochairmen of the meeting were Herman Liebmann, chairman, LTI Alumni Chapter, New York; Terence Giffen, Springfield Woolen Mills Co, president, PTI Alumni Club of New York; Charles Colhard, chairman, N C State College New York Alumni; Paul Atchison, chairman, NBITT New York Alumni; and Frank Ix, III, president, Clemson College School of Textiles, New York Alumni. Further represented, although they have no organized New York textile alumni chapters, were: Bradford Durfee Technical Institute, Alabama Polytechnic Institute, Georgia Institute of Technology, Texas Technological College, and Rhode Island School of Design.

One of the highlights of the meeting was the suggestion by Herman Liebmann of a four-point program designed to "glamourize" the textile industry in the minds of young people.

The points raised by Mr Liebmann were: 1) Industrial leaders should devote several days a year to talking about the textile business to students of leading schools and universities; 2) more articles and books about the industry should appear, with a prize awarded for the most illuminating one; 3) educational motion pictures should be made depicting the latest developments of the industry and should be offered for free exhibition in high schools; and, finally, 4) a permanent Joint Textile Alumni Association should be formed within a framework that would allow for regular meetings and the dissemination of material concerning the textile industry.

Avisco College Aid Program for 1957-58

Ninety-three educational institutions will benefit next year from the College Aid Program of American Viscose Corporation. In announcing the plans for 1957-58 academic year, Henry H Bitler, vice president, indicated that the schools will benefit by means of fellowships, scholarships, grants-in-aid and assistance through educational foundations.

Twenty fellowships for graduate work, ranging from $1,500 to $3,000, have been established in the fields of chemistry, chemical engineering, pulp and paper technology and accounting. Twenty-one scholarships, valued at $500 each, have been awarded to undergraduates who are majoring in textiles, chemistry, physics, engineering and business administration. Ten grants-in-aid have been established to cover textile research, industrial medical research and food technology.

American Viscose's College Program is designed to encourage the study of science, engineering and business administration.

Chemstrand Presents Educational Display to U of Florida

An attractive educational display highlighting the roles of engineers in the chemical fiber industry has been presented to the University of Florida by the Chemstrand Corporation.

This permanent display is located in the University's Engineering and Industries Building. It is the first such display to be presented by Chemstrand to any educational institution.

The display uses flow diagrams and photographs to illustrate the manufacture of Chemstrand's two major products, Acrilan acrylic fiber and nylon, and describes the roles engineers play in such operations.

Warwick Regional Sales Meeting

Technical sessions were featured at the four-day Southern Regional Sales Meeting of the Warwick Chemical Division of Sun Chemical Corporation held recently at the Clemson House in Clemson, S C.

The daily sessions covered reports and discussions on Suntone pigment printing colors, Prym and Warcoset wash-and-wear formulations for cotton, cotton blends and synthetic blended fabrics, Impregnole renewable and Norane 4 Star durable water repellents. They were attended by Warwick salesmen from 11 states.

M J Hoover, Sun Chemical vice president, addressed the meeting on sales aspects of the division's program. Talks on technical service and coordinating sales efforts were also given by H C Whittemore, vice president and general manager of Warwick and R F Pollard, textile sales manager. At a sales banquet held for the Warwick group, R C Edwards, director of development at Clemson College, spoke on the relation of the textile chemical industry to Clemson's School of Textiles.

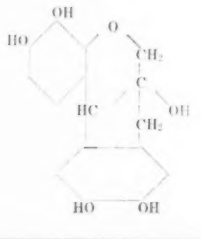
Among those presenting technical papers at the meeting were H B Goldstein, plant manager and director of research at Warwick's Rhode Island plant; S N Nye, manager of Warwick's Sales Application Laboratory, and Justus Hoyt, manager of Sun Chemical's Pigments Division.

Warwick's southern sales district office is located in Rock Hill, S C, and is managed by R G Periello. Warwick is also represented in the southeast by W T H Searcy III, R J Brazeale, and A L McArthur III.

Correction

YOUR attention is called to a printing error on page P245 of the April 8th issue, in the article "The History of the Development of Fast Dyes" by Fred Fordemwalt.

The structural formula for hematoxylin should be as follows:



Olivetti Photoelectric Pantograph

The Olivetti Photoelectric Pantograph for electronic engraving of printing cylinders for roller printed textiles and other materials had its first formal American market showing at the US World Trade Fair last month in the New York Coliseum. It was part of the exhibit of the Olivetti Corporation of America, which had one of the largest individual company displays at the Fair.

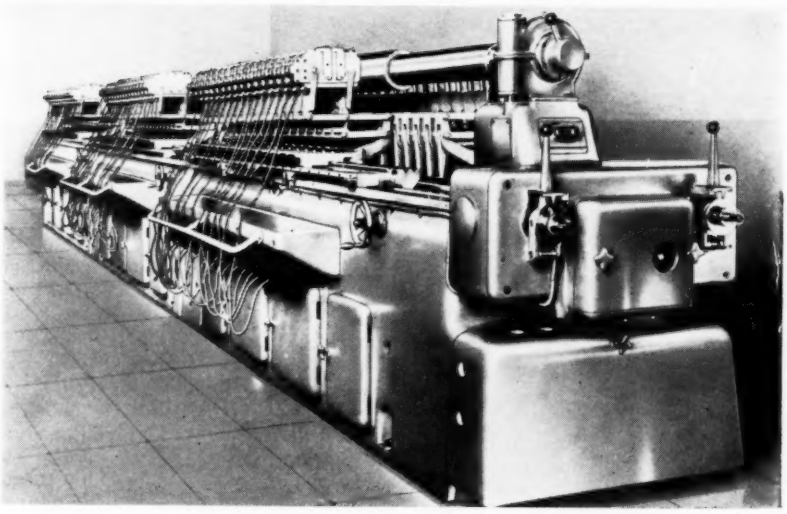
From a photograph or drawing, the Olivetti Automatic Pantograph scanners transmit the design to a bank of diamond cutters which engrave the copper or brass cylinders. The rollers are then used by printers or finishers to print the fabric.

Although the Olivetti Photoelectric Pantograph has been on the world market for about six years, it is believed to be the first equipment of its type ever shown in this country. Of primary interest to the textile industry, the electronic pantograph may be used to engrave rollers for material so printed, as wallpapers.

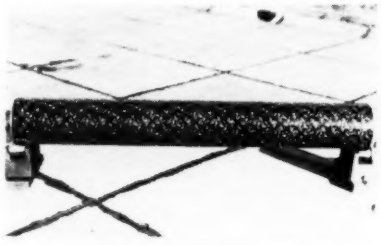
The machine on exhibit at the fair was a single-cylinder model. By adding to the single machine additional cylinder carrying castings, three cylinders can be engraved simultaneously for multiple-color print designs for fashion and home furnishings textiles.

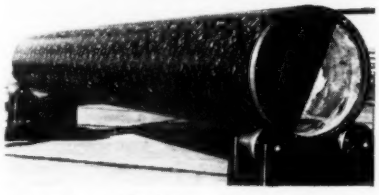
The Olivetti Photoelectric Pantograph is claimed to sharply reduce hand labor, preparatory work, supervision and time. An intricate design which might take more than 65 hours by other engraving systems has been done in five hours, according to executives of Electro-Grave, Inc, of Warwick Industrial Park, Rhode Island, which has the only Olivetti installation in the country, in operation since the beginning of the year. Olivetti reports that the cutting operation, depending on the design, can be done in from one half to one seventh of the time required by other methods.

The engravings are said to be perfect, with absolute neatness of reproduction. Designs of various size can be used and reproduced in the ratios desired as many times as wanted, both in axial and circumferential direction. It is claimed that deformations in height and width are obtained automatically without the necessity of preparing deformed drawings, a point of great importance in textile printing rollers.



Triple-cylinder Olivetti Photoelectric Pantograph





Printing cylinders engraved electronically by Olivetti Photoelectric Pantograph.

Cylinders may be engraved either in hollow or in relief, hachured or screened for the preparation of rollers used for printing textiles, wallpapers, gofferings and so on.

Lanasyn Brilliant Yellow 5GL

Introduced for use with the Sandoz series of neutral dyeing premetallized dyestuffs, Lanasyn Brilliant Yellow 5GL is recommended by the manufacturer for formulation of bright green shades. The properties of Lanasyn Brilliant Yellow 5GL are claimed to be more than sufficient for all applications on nylon. On woolens and worsteds, they are said to meet requirements for men's and ladies' wear. Carbonizing reportedly causes no alteration of shade. Level dyeing properties make this color suitable for piece dyeing, it is stated.

Leaflets describing this dyestuff may be obtained from the District Sales Offices of Sandoz, Inc.

Weighter 546

New Weighter 546 is described by Arnold, Hoffman & Co, Inc as a double-purpose product, in that it combines the desirable characteristics of softener and weighter into one convenient, easily applied finishing agent.

Arnold, Hoffman states that Weighter 546 may be applied to a variety of knit or woven fabrics by any nonsubstantive means. Because it exhibits stability under diverse conditions, other ingredients may be added to the finishing bath to impart additional fabric characteristics. Similarly, ingredients may be added to increase or enhance the softening and/or weighting properties of Weighter 546. Desirable effects are obtained by the addition of Ahcoval A. In general, however, Arnold, Hoffman notes that use of the weighter alone is sufficient for most applications.

Composition of Weighter 546 includes 50%-active ingredients. It is said to dissolve readily in water, and to have excellent storage stability. Conditions normally encountered in finishing and in domestic use, the makers report, will not cause Weighter 546 to discolor fabrics or to impart an odor to the fabrics to which it is applied.

New Sul-Fon-Ates

Three new liquid detergents identified as Sul-Fon-Ates X-35-L, X-50-L, and X-60-LT are now available through Tennessee Corp, Atlanta, Ga.

The three products constitute a series of liquid, multipurpose anionic surfactants based on alkylaryl sulfonates. Tennessee Corp feels that they answer the need for economical, liquid, low-cloud-point detergents and wetting agents for the textile and allied industries.

Also newly available are Sul-Fon-Ate OE-300 and Sul-Fon-Ate BL.

Sul-Fon-Ate OE-300, another anionic surfactant, is said to function as an excellent wetting and rewetting agent. It is designed for use as a rewetting agent in the Sanforizing of cotton piece goods, and, as a toweling finish, reportedly produces in effect what might be called "a water-absorbent finish."

Sul-Fon-Ate BL is a liquid surfactant which reportedly exhibits high surface activity in strong alkaline media and good surface activity in high concentrations of mineral acid. It finds application as a wetting agent and penetrant in mercerizing and kier boiling of cotton and in many other wet alkaline textile processes.

Samples and descriptive literature may be obtained from Tennessee Corp's Market Research and Development Dept, 1330 West Peachtree St, Suite 500, Atlanta 9, Ga.

New Pilling Tester

The United States Testing Company has completed the trials of its new Pilling Tester and has announced the availability of this instrument to industry. The Pilling Tester, which reportedly conforms to ASTM specifications (D-1375 - 55T), has been used for several years in US Testing Company's laboratories. It can be used to test both knitted and woven goods. Test results reportedly are obtained in a matter of minutes.

In the new Pilling Tester, a complex rubbing and twisting action is achieved by contact of a reciprocating table, which holds the abrasive, and rotary head, to which the sample is attached. This rotary action simulates the type of wear instrumental in causing fabrics to pill.

The instrument comes equipped with a grit surface table and a rubber sheet table. In addition, ring clamps on both the tables and the rotary head permit substitution of a variety of other surfaces. Because of this, the Pilling Tester can be employed in durability tests of a wide assortment of articles whose wear depends on a rotary-type action.

Other features of the Pilling Tester include a stroke counter, clearer brush and attachment for varying the pressure on a sample. In addition, provision is made for adapting the instrument for wet-and-dry tests.

Price Reduction for Epon 562; Eponite 100

Recent economies in manufacturing and expansion into new markets have made possible lower prices for two epoxy resins, Epon 562 and Eponite 100, products of the Shell Chemical Corporation. Drum prices for these resins have been reduced from $1.55/lb to $1.15/lb, effective April 15.

Eponite 100 is the basis for promising new textile finishes for cotton and rayon goods which have been receiving commercial acceptance during the past year. Garment materials treated with the resin are said to demonstrate durability crease resistance and durable dimensional stability, and it is claimed that, because of these features, Eponite 100-treated rayons are as launderable by machine as cottons. Eponite resin finish is said to be completely resistance to retaining chlorine from bleaches, thus being particularly useful for white goods.

Epon 562, introduced in 1950, is used as a structural resin.

Improved Dyeing and Finishing Methods for Dynel

New advances in improving dyeing methods and a new durable antistatic finish for Dynel fabrics were reported recently by John M Swalm, Jr, Textile Development Department, Carbide and Carbon Chemicals Company, A Division of Union Carbide and Carbon Corporation.

Among significant developments cited was the introduction of a new dye carrier for Dynel which reportedly makes possible excellent union shades for Dynel blends in a single bath one-stage dyeing. Called DSP-112, the product is said to be easily emulsified and works by increasing the affinity of Dynel for dyes to the level of other natural or synthetic fibers with which it may be blended.

Mr Swalm also described Union Carbide's new antistatic finish, which he stated to be especially important in providing protection against the buildup of objectionable charges of static electricity in Dynel fabrics. Known as Niatex Antistatic AG-2, it may be applied by padding fabrics or spraying garments and reportedly has outstanding durability to laundering and drycleaning.

Cuprophenyl* Green 2BL

Cuprophenyl Green 2BL, a new dyestuff developed especially for cotton and rayon, has been introduced by Geigy Dyestuffs, Division of Geigy Chemical Corp, Ardsley, NY. The color is described as "a bluer, more vivid shade with good dyeing qualities and excellent lightfastness."

Geigy recommends Cuprophenyl Green 2BL as a self-shade, or as the keystone color to produce a wide range of cool summer colors, heretofore not possible with this group. They suggest that an ideal shading color is Cuprophenyl Yellow 3GL, which can be used to produce a wide variety of greens.

Its lightfastness is said to be equal or superior to almost all direct or aftertreated greens on the market. Anticrease finishes, such as TBL or melamine resins, reportedly do not affect the shade of Cuprophenyl Green 2BL, and actually enhance the lightfastness. Geigy states that the color's fastness to washing is very high, and a good reserve of acetate is obtained. Cuprophenyl Green 2BL also is said to have a high rating of fastness to acids and alkalis.

Price - wise, Cuprophenyl Green 2BL, as well as the rest of the range, is in a favorable position with competitive direct, aftertreated, and developed colors. It is stated that the Cuprophenyl colors can be employed effectively and economically for fast color work on cellulosic fibers where slight concessions can be made to the fastest dyestuffs.

Geigy's Cuprophenyl range was brought out in 1951, and has been widened since then to cover almost the entire spectrum. They are dyed as ordinary direct colors and aftertreated with copper and acetic acid or fixatives, such as Gycofix* 67, to develop the true shades and fastness characteristics. It is recommended by Geigy for use on a wide range of cotton and spun rayon fabric as well as on yarn, staple fibers and viscose cakes. Successful applications of the Cuprophenyls include corduroy for sportswear; wind jackets and raincoats in heavy shades; cotton velvet for imitation suede leather jackets: umbrella cloth; apparel fabrics: knitted cotton or staple fiber sport and fashion articles; track suits, pullovers and plush articles; and decorating material. Cotton and staple-fiber fabrics may be pad, jig or winch dyed: knitted wear may be yarn- or piece-dyed; cotton and staple fiber yarns for decorating material, umbrella cloth, knitting or sewing yarns, may be dyed in the hank, cheeses or wrap beams.

* Cuprophenyl and Gycofix are registered trademarks of Geigy Chemical Corporation

• NAMES IN THE NEWS •

Ernest J Chornyei was recently tendered a testimonial by a group of his friends and associates. The party comprised guests from Rhode Island, Connecticut, Massachusetts and New York.

Mr Chornyei, who joined Bradford Dyeing Association in 1938 as superintendent of dyeing, was recently appointed vice president in charge of sales, New York office. He has been active in the affairs of the Rhode Island Section, AATCC, having served as chairman and national councilor.

Fritz H Sarratt, Jr has been appointed quality control chemist for the Southern Plant and Laboratory Group of the Warwick Chemical Division of Sun Chemical Corporation.

Mr Sarratt will be responsible for quality control of all products manufactured at Warwick's Rock Hill, S C plant, and will also assist in the expanded Technical Service Laboratory there.

Before joining Sun Chemical Corp, Mr Sarratt was employed at American Enka Corporation.

Counterclockwise: Mr Chornyei; Ernest R Kaswell, Fabric Research Laboratories; Edward F Mulally, Jr, Queen Print Works, Inc; Arthur F McLean, Glenlyon Print Works; Douglas Martland, Cranston Print Works Co; Walter E Murray, Crown Chemical Corp; Stephen J Bercen, Queen Print Works, Inc; Donald J Eccleston, Hilton-Davis Chemical Co; Matthew J Quigley, Textile Colors Div, Interchemical Corp; and Edward J Allard, National Aniline Div.

Head table (l to r): Matthew J Quigley, Donald J Eccleston and Stephen J Bercen.

Facing camera (l to r): Thornwald Larson, Carbic Color & Chemical Co, Inc; Remus F Caroselli, Owens-Corning Fiberglas Corp; Henry X deRedon, Ciba Co, Inc. Backs to camera (l to r): Benjamin B Meady, Verona Dyestuffs; Raymond K Andrew, U S Oil Co; Edward W Lawrence, Cranston Print Works Co.

Backs to camera (l to r): Roland C Morrison, American Cyanamid Co; Alden D Nute, American Cyanamid Co; W George Parks, Univ of Rhode Island. Facing camera, r to l: Kenneth J Broden, The Sherwin-Williams Co; Francis H Casey, Sandoz, Inc; Raymond W Jacoby; George O Linberg, Synthron, Inc; J Chamberlin, Bradford Dyeing Assoc; Ernest J Chornyei; Ernest R Kaswell; Edward F Mulally, Jr; Arthur F McLean.

Babey

Atlas Electric Devices Co, Chicago, Ill, has announced the appointment of **Matthew J Babey** as its sales and technical service representative for the New York metropolitan area. He replaces **Fred Schlayer,** who retired on April 15 after having represented Atlas in the area for more than 35 years.

Mr Babey was formerly associated with the Dyes Division of American Cyanamid Co, Bound Brook, N J, as supervisor of fastness testing, identification of dyes and technical service exhibiting. He is a member of AATCC, in which organization he is now vice chairman of the Technical Committee on Research, chairman of the Speakers' Bureau, and technical program chairman for the New York Section.

All Atlas sales activities are being transferred from New York to Bound Brook, N J, Post Office Box 205, Telephone Elliot 6-1572. Repair service on Atlas Ometers in this area will continue to be handled by Murray Electric Service Co, 64 West 21st St, New York 10, N Y.

Fred R Sheldon has been promoted to the post of Research Laboratory manager for Becco Chemical Division, Food Machinery and Chemical Corporation, Buffalo, New York.

Mr Sheldon came to Becco in 1939 as a member of the Research Department. He was made manager of pulp and paper research and development in January, 1956, which position he held until his recent promotion.

A L Sanchirico has been appointed a sales representative of the Pigment Division of General Dyestuff Company, sales division of General Aniline & Film Corporation, to handle sales of pigments in the Midwest. He will work out of the Company's Chicago office.

Mr Sanchirico joined the GDC technical staff in 1945 where he handled technical service problems on phthalocyanine and vat-type pigments.

Gaouette

Therrien

Nova Chemical Corp, New York, N Y, has announced the addition of **A F Beane, Norman R Gaouette,** and **Leon E Therrien** to its sales staff.

Mr Beane will cover part of the southern area. He was initially engaged in the application end of the dyestuff business, and is familiar with the dyeing of all fibers. Since 1950, he has been in the selling end, first with Belle Chemical Co and then with Pittsburgh Coke & Chemical Co.

Mr Gaouette, formerly sales manager of the Woonsocket Color & Chemical Co, will be calling primarily on the woolen trade in New England.

Mr Therrien, who was formerly with Glasgo Finishing Co, will serve Nova in the New England area.

Jack Harlow has been appointed general manager of the Velveray Corporation mills in Fall River, Mass.

Mr Harlow replaces **John W Riggenbach,** manager for twenty-two years, who resigned to assume a post with the Fall River Industrial Development Commission.

Mr Harlow formerly was superintendent of Bellman Brook Bleachery in Fairview, N J. He originally joined Velveray Corporation at the company's mills in Passaic and Clifton, N J.

Realignment of the research department of Heyden Newport Chemical Corporation was announced recently. The research organization of the Newport Industries division and the Heyden Garfield (NJ) research organization will be integrated into a single research department under the direction of **Herman Sokol,** vice president, research and development.

Carl Bordenca has been appointed director of research. He joined Newport in 1956 as assistant to the president.

J Harry Stump has been appointed manager of research at Newport Industries' Pensacola Laboratories. Dr. Stump joined Newport in 1947 as a research chemist and has been assistant chemical director since 1951.

D X Klein will continue as manager of research at Heyden's Garfield research center.

Synan

Northgraves

John F Synan and **Walter W Northgraves** have been appointed to the market development department of the Industrial Chemicals Division, Olin Mathieson Chemical Corporation, Baltimore, where they will specialize in the textile, pulp and paper, and leather industries.

Mr Synan was formerly in the company's general research organization and has spent a number of years in the development of bleaching agents for use in the textile and paper industries. Prior to joining Olin Mathieson in 1939 he was a chemist for the Mt Hope Finishing Co.

Mr Northgraves also joined Olin Mathieson in 1939.

Spence

King

Bryant Chemical Corporation has announced the appointment of **Thomas B Spence, Jr** as technical sales representative for Virgina and North Carolina.

For the past ten years, Mr Spence has been associated with the Textile Resin Department of American Cyanamid, and since 1951 has worked out of the charlotte office. Mr Spence will continue to reside in Greensboro, N C.

John A King has been named director of research for Armour and Company.

Dr King has been engaged in industrial research in the chemical and pharmaceutical fields since 1942.

Richard E Milana has joined the staff of Atlantic Chemical Corporation as a technical sales representative.

Mr Milana will serve primarily in the New York Metropolitan area.

Lense

Fieglein

Frederick T Lense has joined the staff of Southern Research Institute, Birmingham, Ala, as head of the Textile Section. Mr Lense was formerly head of the Textile Section Inorganic Chemicals Division, Monsanto Chemical Company. He will supervise industry sponsored textile research at Southern Research Institute.

W N Fieglein has been appointed to the Southwest sales territory of Emery Industries, Inc.

Mr Fieglein, who will handle Emery's complete line of fatty acids, joined Emery's Research Department in 1941, and for the last seven years has been a foreman in the Production Department.

D M Nielsen has been appointed assistant district manager of the New York District Sales Office and **R H Rehm** has been appointed assistant district manager of the Newark District Sales Office of Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation

Mr Nielsen came with Carbide in 1947. Prior to his promotion he was a technical representative in the New York District Sales Office.

Mr Rehm came with Carbide in 1946. Prior to his promotion he was a technical representative in the Buffalo District Sales Office.

Four new assignments in the organization of the Works Engineering Department at the Institute, West Virginia plant of Carbide and Carbon Chemicals Company, were recently announced.

Paul Barna and **D L Cannon** have joined the technical staff; **J F Nelson, Jr,** after six months service in the army, has rejoined the technical staff; and **F G Stech** has been promoted to group leader responsible for industrial engineering functions.

Robert W Davie, formerly with J P Stevens and the Dublin Finishing Plant of Burlington, is now dyer at the Raeford Worsted Co, Raeford, N C.

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